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OBSERVATIONS ON FIRING EXPEDIENTS OF COAST ARTILLERY.

BY SIEGMUND MIELICHHOFER,
Captain, Austrian Fortress Artillery Regiment No. 4.

Reprinted from *Mittheilungen über Gegenstände des Artillerie und Genie Wesens.*

The very different protection provided for the different classes of ships of modern fleets, which determines, for Coast Artillery, the character of the defense as well as the manner of using the coast cannon of various types, renders it necessary that the Coast Artilleryman should know the distinguishing characteristics of the different classes of ships in order that he may thus be able to distinguish between battleships, cruisers, torpedo depot-ships, torpedo-chasers and torpedo-boat destroyers, torpedo-boats, etc.

All the vessels of a squadron intended strictly for torpedo service, such as torpedo-boats, torpedo-boat chasers and destroyers, and torpedo depot-ships are easily distinguishable as a whole from the large battleships and cruisers. They constitute, in their gradation, a group of vessels of from 1500 to 2000 tons displacement, and exhibit, therefore, much smaller dimensions in all respects than even the smallest battleship or cruiser. Aside from this evident distinction, all these auxiliary ships possess guns of only medium and small calibers, of which but a small number are provided with means which not always, or only scantily protect from the smaller projectiles, whilst battleships and cruisers, according to their aims, always carry guns in massive turrets. Once, then, the different types of vessels composing a modern torpedo flotilla are seen, they can by readily distinguished, at a glance, from battleships and cruisers.

To proceed farther, by specifying the distinctive characteristics of the individual types of the vessels intended for torpedo service would, considering the multiplicity and diversity in the views held by the different navies relative to the composition of such torpedo flotillas, demand an exact and extensive study, which is almost impossible in the brief space here allotted ; it is moreover wholly unnecessary seeing that all vessels of this class are constructed without vertical armor protection. Accordingly, projectiles of medium and small cannon will penetrate with certainty the thin steel skins of these vessels, whilst a contest between guns having a plunging fire and the few vessels carrying a weak deck armor, without being impossible, cannot be taken into consideration in consequence of the velocity, mobility and maneuvering capacity proper to such vessels.

In consequence of their special functions, the torpedo-depot boats and the construction boats employed in a few navies only, may attain a displacement varying from 3000 to 6500 tons, and, owing to their magnitude, may be mistaken for the smaller cruisers. They too, however, are easily recognized, partly by their special arrangement for hoisting and moving torpedo-boats and other heavy objects and partly by their very slight armor protection or its total absence. Such ships, moreover, being without any armor protection and therefore easy to overcome, will, according to their funetions, always remain at a distance from the battlefield proper and indeed be conspicuous thereby.

It is essential for coast artillerists to distinguish between battleships and cruisers, because the divergent primary aims of both these war vessels demanded varied armor protection, and because the co-operation of both types in battle against coast fortifications is not only possible but even probable.

The battleship, which constitutes the true fighting element and should, therefore, resist the fire of even the most powerful guns, demands a strong vertical and an adequate horizontal armor protection, whilst the cruiser either wholly dispenses with vertical armor or else possesses it of but slight strength and extent, for which reason it is frequently protected by strong deck armor, sometimes as thick as 150 mm.

These undoubtedly important distinctions, it must be admitted, require the artillerist to fight against battleships in quite a different manner from that employed against cruisers.

At the first glance it would seem impossible to distinguish vessels from their demensions and displacement considered broadly, because to the superficial observer these are practically uniform.

And yet for the practical eye external distinctions do exist.

The following table gives a comparison between battleships and cruisers of the leading European powers, made under similar conditions, i. e the ships compared have about the same tonnage.

Nation.	Displacement.		Length.		Beam.	
	Battleships.	Cruisers.	Battle-ships.	Crui-sers.	Battle-ships.	Crui-sers.
	Tons.		Meters.		Meters.	
Germany	5,300—11,000	5,700—10,500	75—115	90—120	18—20	16—20
England	6,000—15,000	7,000—14,000	85—122	110—150	16—23	17—22
France	9,000-13,000	8,000—11,500	95—126	120—145	18—22	18—19
Italy	9,500—16,500	6,500—7,500	100—126	100—105	20—24	17—18
Aust.-Hung.	3,500—7,500	4,000—6,000	73—93	98—112	15—19	15—17
Russia	9,000—13,000	8,000—14,500	100—130	100—130	19—23	17—21

These data give the ratio between the mean length and breadth of the hull as 5.5:1 for battleships and 7:1 for cruisers; these show, under the assumption of a nearly similar displacement, that cruisers are always built longer and narrower than battleships, and are consequently much more slender than the battleships with which they are compared. Assuming this to be an undoubted principal distinction, it is still to be conceded that it would be difficult for an unpracticed eye, i. e. for one having no occasion to undertake comparative studies practically, to at once discover these distinctions for the purpose of a practical application.

Still other distinctive characteristics may be adduced.

Whilst battleships generally carry guns of between 28 and 43 cm. calibers, mounted in pairs in two turrets, one fore and one aft, thus constituting a normal armament of four guns, cruisers usually have but two guns, varying in caliber from 20 to 24 cm., each mounted in a small turret. This distinction in the equipment and mode of mounting ought to be easy to the artillerist because his eye has been accurately trained to this end, and should be particularly so when adequate means for observation, i. e. good telescopes, are provided; the importance of the latter, naturally, increases with the distance.

In modern times, however, cruisers are likewise dispensing, as much as possible, with covered turrets for the heavy guns, the latter being mounted mostly behind semi-cylindrical barbettes constructed of armor possessing suitable resisting capacity. By this means the upper boundaries of the hull present to the eye an approximately unbroken, rectilinear form, freed, more or less, from all the turret and casemate structures peculiar to battleships.

Finally, the general transverse section of the ship may likewise serve as a basis for judgment. Figure 1 represents the transverse section of a battleship, Figure 2, that of a cruiser.

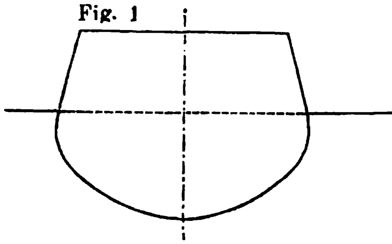

Fig. 1

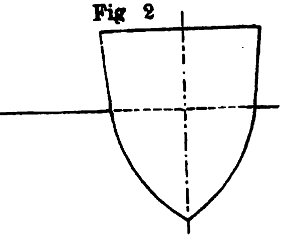

Fig 2

The most important and essential distinctive characteristics would accordingly be:

1. The ratio between length and breadth.
2. The transverse section of the hull.
3. The upper bounding line of the ship.
4. The equipment with heavy ordnance and the manner in which the latter are mounted.

These fundamental characteristics would be all the more satisfactory could both classes of ships be seen close together so as to admit of comparative observations.

Let us now examine the true fighting element of the attack on coast fortifications, namely, the battleship, and premise the subsequent researches that it will, moreover, be the principal fighting element, for the reason that the character and strength of its armor guarantees it the greatest protection from the coast guns, while its own artillery, being the most powerful ordnance within reach of the attack, renders probable the greatest measure of success.

The structure of ships varies according to the years in which they were launched and according to the views in favor at the time, the question of principles involved being, for the most part, that which decided. In this way important distinctions arose which exert an influence upon the artillery attack of these ships. In the majority of cases it was attempted to build as many vessels as possible after one principle; this permits a separation into classes or types. In the last ten years, however, views have changed, almost from year to year, so that only states having extensive fleets could actually incorporate a considerable number of battleships into one class, whilst the smaller navies, forced to be contented with the laying down of but one or two ships annually, do not even possess extensive classes; in many states, indeed, each ship constituting a type in itself. But even in the large navies the changed views were not without abundant influence upon the individual ships under immediate construction, since the more or less advanced structural completion permitted a partial employment of innovations in some of the ships, so that particular questions were differently solved within the classes, quite often producing differences in armor protection and consequently influencing anew the coast artillery attack.

The following group of vessels, taken from the fleet lists of the indicated European sea-powers, ought to illustrate what has just been said.

GERMANY.

Kaiser Friederich class	5 ships, all alike.
Brandenburg "	4 " "
Sachsen "	4 " "
Oldenburg "	single ship.

ENGLAND.

Formidable class	3 ships, alike.
Majestic "	9 " "
Royal Sovereign class	7 " "
Hood	single ship.
Canopus class	6 ships, alike.
Nile "	2 " "
Barfleur "	2 " "
Benbow "	6 ships, 4 alike and 2 differing from each other and from the type ship.
Renown	single ship.
Sans Pareil	" "

The battleships of the second and third order generally have few classes and are mostly single ships.

FRANCE.

Charles Martel class	5 ships, 2 alike, and the others differing from each other and from the type ship.
Amiral Baudin class	2 ships, dissimilar.
Charlemagne "	3 " 2 alike, 1 different.
Marceau "	4 " alike.
Devastation "	2 " "
Colbert "	2 " "

Jena, Brennus, Amiral Duperré, Redoutable, Friedland and Richelieu are single ships.

ITALY.

Italia class	2 ships, alike.
Re Umberto class	3 " 2 alike, but differing from the type ship.

Benedetto Brin class	3	ships, alike.
Duilio "	2	" "
Ruggiero di Lauria class	2	" "
Ammiraglio di St. Bon class	2	" "

RUSSIA.

Peresvjet class	2	ships, alike.
Sebastopol "	2	" "
Imp. Alexandre II. class	2	" "
Tri Svitatetelja "	2	" "
Ekaterina II. "	3	" "

Thus Germany has, in 15[*] battleships, 4 distinct types; England, in 38 ships of the first rank, 9 classes with several deviations from the type ship; France, in 24 ships, 12 types with deviations; Italy, in 15 ships, 6, and Russia, in 18[†] ships, 11 classes.

The following deductions will show how varied the action of coast artillery becomes through the causes indicated above. For this purpose, the battleships of only the Italian and German fleets will be taken into consideration, as an extension of the investigation to include the ships of the other fleets would unnecessarily extend this article.

Whilst, for example, the belt armor of the German *Kaiser Friederich* class will be penetrated within about 300 m. by the Krupp 28 cm. L/50, C/89, this distance is about 4500 m. for the *Brandenburg* class and nearly 6000 m. for the *Sachsen* class. The *Kaiser Friederich* class has a rather strong casemate armor which will resist penetration beyond 1000 m. by the 15 cm. L/40 rapid-fire gun; the *Brandenburg* class, not being thus protected, will be exposed to the action of this gun which, even at its greatest range, will be able to successfully attack the 10.5 cm. broadside batteries of this class of ships. The *Kaiser Friederich*, *Brandenburg* and *Sachsen* classes have a deck armor which is absolute proof against the 21 cm. mortar in use, consequently can only be successfully attacked by heavy ordnance. Therefore the parts unprotected by deck armor must be attacked and hence ought to be known. In the *Kaiser Friederich* and *Brandenburg* classes the entire deck is protected with armor, they are therefore completely unassailable by the 21 cm. mortar; in the *Sachsen* class, however, the part protected by the belt armor has no deck protection. This space extends from casemate to turret, the middle being indicated approximately by the funnels or mast respectively.

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[*] Only 14 appear in the list.

[†] Only 12 are given in the list, and 5 classes, other 6 probably single ships, thus giving result as above.

With the exception of the ships of the *Duilio* and *Ruggiero di Lauria* classes, whose side armor will be penetrated within distances varying from 3000 to 4000 m. by projectiles from the Krupp 28 cm. L/40, C/89 gun, and of those of the *Italia* class, which generally lack side armor and are therefore exposed at all distances, the armor belts of all the remaining ships are assailable at about 4000 m. by the very same projectiles. The following results are obtained with the 15 cm. L/40 gun: *Italia* class, only the turret armor is unassailable; *Re Umberto* class, turrets unassailable, side armor and secondary batteries assailable within 5000 m.; *Benedetto Brin* class, turrets, armor belt and secondary guns unassailable beyond 1000 m.; the greatest effect is promised by firing at the waterline about midway between the two funnels, as the deck armor here forms an upper extension of the armor belt above the water line. In the *Duilio* class only the unarmored parts are assailable just as in the *Ruggiero di Lauria* type; in the *St. Bon* class, on the contrary, the battery armor is destructible beyond 1000 m. The fire of the 21 cm. mortar is inefficient against all classes because the entire hull of the ship is, in every case, covered with rather strong deck armor.

Similar investigations may also be made among the cruisers of the different navies, the results attained being similar in both cases. The division of ships into so many classes and the differences existing between the types, as, frequently, between the individual ships of the same class, coupled with the fact that the attack will not consider the division into classes in arranging his fleet, determine a different mode of engagement against nearly every ship. The battery commander must, therefore, know the name of the ship designated as his target, since this knowledge includes the peculiarities of the ship and consequently indicates the system of attack likely to prove most successful.

At the first glance, this requirement seems too high and unlikely to be attained. Yet the matter is not so difficult, as may be seen by referring to the *Marine-Almanach* which shows the differences between the individual ships to be so numerous and characteristics as to render their distinction tolerably easy.

However excellent the Almanach may be as a hand and reference book, it can not be seriously considered as a resource in the above sense because only a small fraction of the battleships can be represented therein and because the manner of representation, serving other aims, is unsuited to artillery requirements.

With a little practice, however, it will certainly be easy, especially in time of war, to recognize a ship from good photographs, the latter including a side and end view of each ship, the more so as it is known with certainty with what navy a condition of war exists. Moreover, through a proper bureau of intelligence, the ships composing a fleet ought to be known as soon as the latter makes its appearance. There would thus be very narrow limits within which to seek the desired information.

The accurate knowledge of the internal arrangement of ships does not appear, at the first glance, to be absolutely necessary to the coast artillerist. The general principles governing the internal arrangement of ships prescribe that armor protection shall be provided for those really vital parts which, being struck by the enemy, would endanger the ship and its floating and maneuvering capacity, so that knowing the position and strength of its armor, we know the vulnerable parts of the ship.

Seemingly unimportant details may often, however, be placed in unarmored spaces and may thus, by their destruction, seriously endanger the ship. Thus a ship also possesses weak points.

The catastrophe of Santiago de Cuba, where the destruction of an unprotected detail resulted in the sinking of the cruiser *Infanta Maria Teresa,* must constantly be held up as an example. It was known that the main pipe of the steam fire engine of this ship passed through unarmored spaces. This pipe was rendered useless at the very beginning of the fight by being struck by an American shell, leaving the ship powerless to either extinguish or control the fierce flames, which soon afterwards extended to the woodwork of the Admiral's cabin which had been struck by a second shell. The destruction of this detail was undoubtedly an accident as it was not generally proposed to operate against it. Should such points, however, be actually known, a few projectiles might always be employed against them, particularly when there are such available as are ineffective against the principal armor.

In conformity with the above, it is important that the internal arrangement of all ships be accurately known.

Finally there remain certain tactical data peculiar to ships, which it is essential the coast artillerist should know.

The most important of these is the steering or turning circle of the ship, since it indicates the maneuvering capacity of the ship and consequently influences the firing system to be selected. This datum acquires a real interest only when the following data are known :

1. The time occupied in putting the helm hard over.
2. The distance advanced by the ship in the original direction due to its failure to at once answer the helm, called the *advance.*
3. The time required to complete the smallest turning circle ; this can not be derived from the speed directly because the latter is reduced in turning.
4. The speed of the ship.

With the exception of the speed, which is given for each ship in the *Almanach,* the other data are more or less difficult to learn for the reason that most navies regard them as secrets. Generally, however, the tactical diameters of battleships are specified as being approximately between 350 and 1500 m., the turn being completed in from 4.5 to 12 minutes. The time occupied in putting the helm hard over varies from 25 to 30 seconds, while the advance, depending upon the magnitude and speed of the ship, varies from 100 to 200 m.

It should now be explained why this data is required by the coast artillerist.

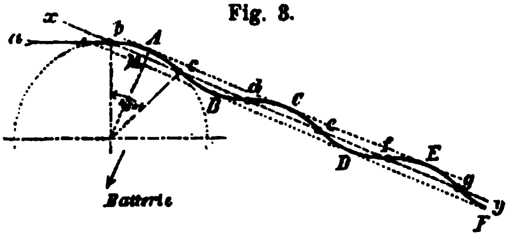
The view that ships avoid the effect of artillery fire by simply moving over an irregular course has been established in many ways, and demands a special fire control, applicable in all circumstances. Such a fire system, naturally, can not be as accurate as one based on the assumption of a regular course, and should therefore be used only when the latter is inapplicable. For this reason a thorough investigation should be made to determine to what extent ships may take an irregular course and beyond what limits the fire of coast artillery will be rendered inefficient by an irregular course, leaving out of consideration the fact that a vessel pursuing an irregular course will likewise diminish the efficiency of its own artillery.

Let us assume that the tactical diameter of a large ship is 700 m., that its speed is 12 knots and its advance 100 m.

In the execution of such a problem the ship will undoubtedly turn on its tactical diameter, and, combining segments of the same arc into one path, will form a sinuous line, shown in figure 3 as composed of octants. It is now important to determine the time during which the ship is exposed to fire in passing and the relation of this time to the rapidity of fire of the coast guns.

To bring the ship about the helm must be brought hard over in the direction of the turn ; should it previously have been in the opposite position, 30 seconds will be required to make the shift, in which time the ship, under its assumed speed, will move 180 m. Now as the advance is 100 m., the movement must be commenced 280 m. in distance, or 45 seconds in time, in advance of the turning point proposed, for example at the point a, Fig. 3, in order that the turn may be executed at the point b. From this it follows that 45 seconds is the inferior limit of the maneuvering capacity of a ship whose tactical diameter is 700 m.

Fig. 8.



From the circumference of the turning circle it may now be easily computed that the arc of the latter passed over has a developed length of 275 m.; the helm must, therefore, be shifted at the points b, c, d, e, f, at the very beginning of the turning contemplated for these points in order that the subsequent turnings may be executed at the points c, d, e, f, g.

A case still less favorable to the coast batteries concerned than the one just indicated, can only occur when the axis xy of the sinuous course of the ship, instead of being a straight line, as in figure 3, becomes a circular arc, as in figure 4, with its center at the firing battery. All other possibilities are excluded. The employment of a higher speed requires that the tactical diameter be increased as otherwise the helm can not be obeyed. The arc then becomes flatter and the curved path of the ship approaches more nearly the right line than the circle ; should it, however, be desired to move in smaller circles, tenths or twelfths of quadrants, for example, the tactical diameter must either be increased or the speed diminished.

Both of the cases cited are most unfavorable to the coast artillerist for the reason that the elementary paths succeed each other most rapidly ; these paths are, however, related to the curved axis xy, whose general direction is determinable. Should the axis, however, be known, the efficiency of the coast artillery fire would not be materially diminished, even if it were impossible to predict the intersections of the curved path with the axis, as points for the direction of the fire. Knowing the length of the arc bc, it may be easily calculated that the greatest distance AM, between the arc and the axis, for a ship having a tactical diameter of 700 m, is about 25 m. (accurately 26.6 m.) This measure, which thus indicates the greatest deviation of the course above or below the axis, varies directly with the tactical diameter. The various coast guns are already affected, however, with longitudinal dispersions which, at the normal fighting distances for artillery—2,000 to 2,500 m.—amount to 25 m., so that the greatest deviations from the axis are less than the dispersions of the guns. The firing elements might, therefore, be selected, without material error, for the axis of the curved path, without considering the points of intersection b, c, d, etc.

Now it ought to be readily conceded that the location of the axis of such a curved path will require much experience and practical knowledge; that even the most accurate location is uncertain, for the reason that the path of the ship, not being dependent upon the will of the artillerist, may be changed at pleasure within the given limits; that it consequently seems better and more advantageous to operate against points which have been accurately predicted.

The relation between the rapidity of fire and the turning circle of the ship is a decisive factor, which not only facilitates the solution of the preceding question but also that relating to the kind of fire to be employed.

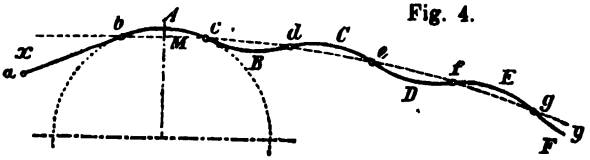


Fig. 4.

Referring to the curved paths, figures 3 and 4. it is to be observed that even if the target is receding, as in figure 3, it will still constantly approach in the segments AB, CD, EF, etc., relative to the segments BC, DE, etc., in which, on the contrary, it will constantly recede. Thus, the segments AB, CD, EF or BC, DE will be, to a certain extent, traversed in a regular manner. Consequently if the loading of the guns begins when the ship is at the point A, the rapidity of fire of the single gun, for the case of a ship having a tactical diameter of 700 m., must not exceed 4×45 sec., 2×45 sec. or 1×45 sec. in order to deliver at the point B, the fire of at least one, two or four guns, respectively, the supposition being, of course, that the firing system to be employed is that of a regular course.

Should the individual guns of a coast battery require more than 4×45 sec. = 3 minutes, to completely prepare them for firing (the latter including the operation of the range finder) the ship to be attacked (its tactical diameter being 700 m.) would really traverse an irregular course for such a battery, thus requiring the guns of the latter to employ a special fire control. With guns requiring from 1.5 to 3 minutes to put them in readiness for firing the single fire may be used, with those requiring from 45 sec. to 1.5 minutes, half battery salvos and with those requiring less than 45 sec., battery salvos may be used, the assumption being that the ship traverses a regular course.

It may now be inferred that a reduction in the length of the tactical diameter of ships to the smallest hitherto attained, namely 350 m., would demand a continual increase in the rapidity of fire of coast guns, or, what amounts to the same thing, that heavy coast artillery, with a rapidity of fire increased to the utmost limits, might in the end be obliged to succumb to the maneuvering capacity of battleships.

This inference may, however, be erroneous. Since the shifting of the helm requires at least 25 seconds and the ship, with even the smallest speed, attains quite a decided advance, it may be said that at least 30 seconds is consumed before the ship enters a new course. Now the length of the segment of the path is wholly unimportant to the coast artillerist, provided a definite time limit is established for traversing the same, so that the inferior limits for the rapidity of fire of one, two or four gun salvos, may, therefore, be fixed at 4×30 sec., 2×30 sec. and 1×30 sec., because the ship must, in every case, traverse a regular course within the period of 30 seconds. In other words, the constant diminution of the tactical diameter to the utmost limits would, in consequence of the ship being constrained to traverse a regular course during 30 seconds, exclude the advantageous employment of the other important functions, as, for example, the speed.

From the above it follows, that if the turning circle of a ship, including all its subordinate data, and the rapidity of fire of one's own guns be known, it can be very accurately stated whether, for these guns, the opposing ships can actually traverse an indeterminate course, and what firing system as well as what kind of fire is to be selected; or, the complete *fire* action of a battery with a fixed armament (consequently a definite rapidity of fire) is a function of the turning circle and speed of the particular ship. This function can not fall below an accurately determined minimum and is easily expressed in tabular form.

The objection that modern twin-screw ships turn almost on their centers can not be seriously considered, because such a maneuver requires that one of the screws drive the ship ahead while the other screw is reversed, so that the question of a forward motion can not generally exist; the whole maneuver, moreover, depending upon the turning angle, requires so much time for its execution that it permits an action against a stationary target, the effect of which is greater or less depending upon the rapidity of fire of the guns. A summary of what has preceded sufficiently indicates also the necessity for firing expedients in coast batteries; such expedients differ quite materially from those employed in field fortifications.

The firing expedients are as follows:

1. The turning circles of ships and all supplementary data pertaining to them, hence tables from which the firing system and the kind of fire may be determined, for battery commanders.
2. Sketches containing the accurate internal arrangement of all ships and the position of the armor relative to the internal spaces as also its strength, for battery commanders.
3. A properly adjusted platting chart, at the range finder.
4. Photographs of all ships, including side and end views, for district artillery commanders.

It still remains to be shown how these firing expedients are to be used.

It is not necessary to further illustrate the use of turning circles and their data or that of the tables derived from them, since this has already been accomplished by the preceding deductions.

The photographs of the ships are at the observing station of the district artillery commander, who uses them for the identification of the individual ships. After the belligerent state is known (and it could, perhaps, be learned beforehand, what particuliar ships would be sent against our port) the limits are narrowly drawn. The solution of this problem presents difficulties mostly in the beginning, for in a short time the differences between the individual attacking ships are so impressed upon the mind that they can subsequently be recognized even without the use of pictures. Advantage should, of course, be taken of the time elapsing before the beginning of the artillery battle, which is the period for which this information is really needed.

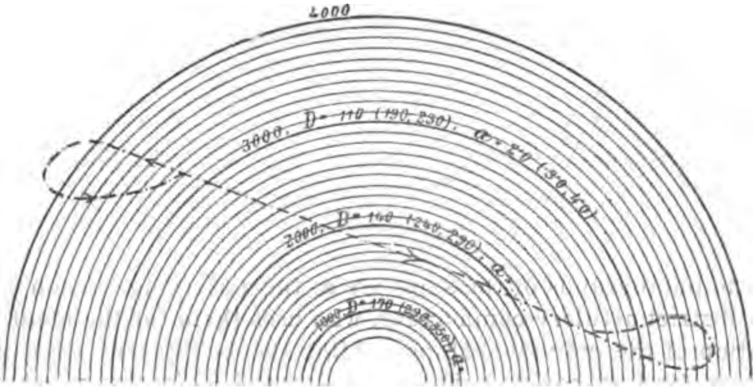
The very short telephonic command of the district artillery commander to commence firing, will therefore only designate the target and the problem, including without fail, however, the name of the target, or, among ships of uniform classes, the name, at least, of the type ship, thus:

"Group (Battery) K. Leading ship, which is armored ship X, (which is type Y) etc.!"

Extensive firing dispositions should not even be looked for at this time for the reason that they lack justification and mean loss of time.

At the observing stations of the battery commanders are to be found the afore described firing expedients from which are to be derived the position of the armor and its strength, the existence or non-existence of weak places in the ship, the latter's turning circle, including the auxilliary data, together with the firing system and kind of fire to be employed. The platting chart must always rest upon the range-finding table and the course of the ship platted upon it even during the firing. The chart should itself contain all the data of the penetrating capabilities, figure 5, and should have conspicuously designated the limits which separate the space, in which the principal armor of the ship in question may be penetrated by armor piercing projectiles, from that in which this is no longer possible.

Fig. 5.


4000
3000. D = 110 (190, 230). a = 20 (30, 40)
2000. D = 140 (240, 290). a =
1000. D = 170 (320, 350) a

D = penetrating capability for hardened nickel steel, (or nickel steel, steel, etc).
a = decrement of D for an increase of 100 m. in the distance.

The battery commander first takes from the table the firing system (whether for a regular or an irregular course) and the kind of fire (by piece, or by two or four gun salvos), lays out the sketches of the ship designated as the target and observes, through the progressive platting of the course, the progress of the battle with reference to the kind of projectiles to be employed as determined from their effect.

Let a battery of heavy coast cannon having the penetrating capabilities as indicated in figure 5, have to attack, for example, the Italian battleship *Benedetto Brin* (*Marine Almanach,** pp. 232 and 378), having the course as shown in the same figure. *Brin* has a belt armor of hardened nickel steel 150 mm. thick, equally strong turret armor, and a deck armor 80 mm. thick, which, to a great extent, constitutes an upper extension of the belt armor above the water line. It follows, therefore, from the platting chart and sketches, that down to about 2,000 m. only unarmored parts can be destroyed and therefore percussion shell should be used, while within 2,000 m., the belt armor being penetrable, armor piercing projectiles should be used. In consequence of the peculiar position of the deck armor, it will be advantageous to aim at the water line of the midships between smokestacks, for the reason that a penetrating hit in this locality would greatly endanger the floating power of the ship.

It is readily to be conceded that it will not be easy, particularly at the start, to carry out these principles by adopting firing expedients; in the interest of success, the existing difficulties must, however, be overcome. And in conclusion practice certainly makes perfect.

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* Or Brassey's *Naval Annual*, 1900, p. 253; Jane's *All the World's Fighting Ships*, 1900, p. 175.
ED.

[Translated by Lieutenant F. E. Harris, 3d Artillery.]

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LAND DEFENSES OF MANILA BAY, MAY 1, 1898.

The land defenses of Manila Bay may be divided into two branches:

1. Subaqueous.
2. Batteries.

SUBAQUEOUS DEFENSES.

The first can be dismissed with little notice; for, although official reports and less authentic information regarding the battle of May 1st were to the effect that torpedoes or mines were exploded, prematurely, in advance of the *Olympia*, subsequent investigation has shown that supposition was erroneous. There were neither torpedoes nor mines planted. Torpedoes had been ordered sent by the home government, but Admiral Montojo makes it one of the arraignments against the administration, that, in response to angry demands of the people it was given out that torpedoes had been sent to the Philippines, although it was known that, at the time, they had not reached there. Montejo had fourteen torpedoes in all, of these only five could have been placed to defend 2000 metres of space, as this was the capacity of the cable procured at Hong Kong.*

THE BATTERIES.

The land batteries were in three groups: first, at the entrance to the Bay; second, at or around Cavite; third, before Manila proper or its suburbs.

Corregidor Island stands athwart the entrance to Manila Bay and divides that entrance into two channels, Boca Chica and Boca located as shown in the accompanying map.

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* Comments of Rear Admiral Plüddemann: War with Spain.
Official report, battle May 1, 1898.
Defense of Admiral Montojo before court-martial.
Lieut. C. G. Calkins, U. S. N., *Proceedings U. S. Naval Inst.*, June, 1899.
Verbal assurances of Captain Chavarre, Spanish Artillery, and other Spanish officers after fall of Manila.

NOTE. Since writing the above I am informed by Lieut. S. A. Cheney, U. S. Engineers, that a Native who helped plant them assured him that seven (7) torpedoes were in Boca Grande. But the truth of this is doubtful. The Natives are gross exaggerators, to speak considerately. Admiral Montojo's positive statement is that he could only have planted five (5), while he leaves the inference to be drawn that he planted none. The casual reader, or professional for that matter, might think it strange that, after two years, any points like this should remain in doubt, but after he had lived here that long he would have learned that he who believes anything in this country that he does not see, is liable to have cause to revise his judgment. The torpedoes would have been useless there in 30 fathoms of water.

to revise his judgment. The torpedoes would have been useless there in 30 fathoms of water.

Grande, the former 8100 yards, the latter 10,500 yards wide. It was through the latter the American fleet entered. The armaments guarding these channels were as follows:

Boca Chica: 1st, Sisiman Battery on Punta Gorda. Three 6¾-inch Armstrong M. L. Rifles. They were 10 feet above water level, were wholly unprotected by parapet, mounted on a stone platform. 2nd, Lasisi battery, of three guns, similar to the Sisiman. 3d, the Corregidor battery. This consisted of three 8-inch Armstrong M. L. Rifles on point just west of Corregidor Bay. It had a low earthern parapet 16 feet thick.

Boca Grande: 1st, Pulo Caballo battery. This is at eastern end of Pulo Coballo Island, at the water's edge, and 10 feet above it. It consisted of three 6-inch Armstrong B. L. Rifles. The parapet was low, of stone, 12 feet thick. 2nd, El Fraile battery, consisting of three B. L. Rifles from Spanish Cruiser *Velasco*. It is on a shelf at the eastern end of the rock, 20 by 40 feet, 10 feet above water, with a two-foot protective wall. These guns have disappeared, either carried off by Aguinaldo, or pitched by some one into the water. They were in position on May 1, 1898. 3rd, Restinga battery, on Punto Restinga, Cavite Province, and consisted of three muzzle loading rifles.

The batteries at Cavite consisted of an open earth-work, supported by stone walls, garnished by two steel rifled 15 centimetre (5.85 in.) calibre, of modern construction. This battery was at Sangley Point, the extremity of the peninsula on which Cavite stands. The parapet was 20 feet thick. One gun bore down the Bay towards Corregidor, the other on the Bay off Cavite. These were the only guns of modern construction in the vicinity of Cavite.

There were some old-style fortifications immediately at Cavite. Fort San Felipe is bastioned with stone walls like those defending Manila. There is a small battery at the eastern end of the Navy yard. Surrounding Cavite proper is a bastioned wall that is provided with casemates opposite the Plaza de la Fuerza. The only guns mounted are a few old iron pieces on the eastern battery.

It is believed that, on May 1, 1898, the only guns of the whole Cavite group that it was safe to fire were at Sangley Point. The other defenses were on a par with Fort Marion, Florida, mere objects of curiosity, as specimens of ancient Spanish fortifications.

The defenses of Manila proper were twenty-four batteries located as shown in the accompanying map.

1. Malecon del Sur.
2. Escollera.
3. Compuerta.
4. Fuerza Santiago.
5. Rebellin San Francisco.
6. Bateria San Francisco.
7. Puerta Postigo.
8. Plano Santa Isabel.
9. Camino Cubiero.
10. San Diego.
11. Puerta Real.
12. San Andres.
13. San Lorenzo.
14. Rebellin Parian.
15. Puerta Parian.
16. San Gabriel.
17. Magallanes.
18. Aduena.
19. Herrerias.
20. San Antonia Abad.
21. Malate.
22. Luneta.
23. Pastel.
24. San Pedro.

The armaments of these batteries consisted of 91 bronze smooth-bore mortars, howitzers and cannon, and 58 rifled howitzers and guns of bronze, iron and steel. The calibers of the howitzers ranged from 2.34 to 4.68 inches; of the mortars from 5.85 to 12.48 inches; of the guns 3.12 to 4.85 inches smooth-bore, and 2.73 inch—9.36 inches for rifled guns. Thirteen of the rifles were steel, the largest being 5.85 inch caliber, of which there were two. None of this artillery appears in the official list of Spanish Ordnance of 1898. The heaviest projectile of the 24 cm. iron gun, rifle, hooped with steel, weighed 320 pounds, with initial velocity of 1389 feet.

The projectiles were shrapnel or shells either penetrating or common.

It thus will be seen that none of the guns for defense of the City of Manila proper were of a power required to guard mine-fields in an ordinary system of mines and torpedoes. As was exclaimed by a Spanish officer with agony in his face, "there was no defense possible." The carriages of the heavier pieces had been readjusted and improved so that the extreme range was 4.5 miles; but, of course, effective range was much less. The maximum range of the 8.19 inch mortar was 2.5 miles.

None of the defensive works were of a nature to render them really formidable to resist attack of modern artillery. All the forts were of ancient design and construction; and while doubtless they were exellent in their day and generation, the system to which they belong is now as antiquated as is the smooth-bore artillery decorating their parapet. Three of the works are of masonry: San Felipe at Cavite; San Antonio Abad at Malate; and the fortification surrounding the Walled City; the others were open earth-parapets of weak construction, having regard to the demands of sea-coast defense in the year 1898.

In fighting power the guns of the navy, especially the American 8-inch breech-loaders, far exceeded anything in the shore defenses. The muzzle energy of the Spanish 24 cm. (9.36 inch) rifle, their most powerful weapon, is 4,279 foot tons, while that of the 8-inch breeh-loader of the American squadron was 6,934 foot tons. The muzzle energy of the 15 cm. (5.85 inch.) Hontoria, at Sangley Point, was 2000 foot tons, that of the U. S. Navy 5-inch was 1664 foot tons. The Hontoria guns of the Spanish were as good as any of their class, but, although the best land-defense ordnance mounted in Manila Bay, they were at best mere mine-field guards, as before remarked, and in no degree competent to compete with the heavier guns of the American navy.

Except at Sangley Point, the resistance of the land-batteries was a vain effort. After the advance of the invading squadron had passed Corregidor one or more shots came from the batteries there, while at the same time the battery El Fraile awoke to feeble action. At subsequent stages of the naval attack, the Escollara battery fired 4 shots; Fort Santiago 10; Compuerta battery 2; San Pedro, 8; Luneta, 12; San Francisco, 10; Rebellin San Francisco, 14; or 60 shots in all; but, in no instance, could it have been supposed that a single shot was proving effective, the hostile fleet being beyond extreme range of the land batteries.

Sangley Point battery made a diffrent record. First Lieutenant Valentin de Valera, Spanish Artillery, commander, with one Sergeant and seventeen artillerymen to work the two 5.85 inch Hontoria guns. There was an infantry support of 1 officer and 25 men, but their services were not required. An interval of seven minutes at each piece was prescribed between shots, of which there were altogether 104 fired. Finally, the American ships assailing the battery from the rear, where the fire could not be met, Lieutenant Valera abandoned his untenable position.

What damage was done to the attacking vessels by the guns of Sangley Point is not definitely known. The Spanish ships were firing at the same time and objects, so it might well be a question whether shots received by the American ships came from guns ashore or afloat. The artillerists give themselves credit for several hits, each one when delivered being cheered to the echo by the expectant Spanish fleet. It has been said that the result of one shot from the battery was really quite serious to the Baltimore, but whether this shot came from the battery or the Spanish ships will perhaps never be known.

The battery received, at rather short range, considerable attention from the guns of the attacking fleet. The masonry was, as a result, in a disheveled condition, but the earth part of the parapet was practically uninjured. Neither was either gun or its carriage in the least out of working order when the garrison abandoned the battery. No one of the personnel was injured: and this good fortune followed them during their retreat, notwithstanding they continued still to be fired upon by our warships.

Several shells were fired at the Luneta battery that day, but, although good line shots, they all went over several hundred yards. Not one burst. The Spaniards opened them, finding therein something besides powder, and thereupon cabled to the home government that the American projectiles contained in the interior "charges of inflammable green cloth in violation of the rights of men in honorable warfare." Such was the Spanish defence of Manila! Bewailing the inhumanity of their enemy who was knocking about their ears the last vestige of their colonial empire. No injury to either the personnel or material of the battery was done by these shots. As the Spanish Admiral regarded three thousand metres,—say two miles—as placing the American fleet beyond effective range of his navy guns, it readily can be understood how harmless to our ships was the return fire of the feebler batteries in front of the City of Manila.

The foregoing facts are not of historic interest alone. Manila Bay is now under the sovereignty of the United States. Its condition of land-defence is now no better than on the 1st of May, 1898. This cannot be matter of indifference to a nation reaching out near and far for colonial possessions, which must be defended, successfully, or they become a source of national humiliation. Spain had been warned in the Fall of 1897 by Governor General Prisno de Rivero, that Manila was in no posture to resist attack: and this was only a reiteration of previous warnings. And although his successor, Basilio Augusté, on the eve of the destruction of the Spanish fleet, published a bombastic proclamation, predicting victory for the Spanish arms, the event showed the emptiness of these boastings unsupported by proper armament and trained personnel competent to use them. The condi-

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NOTE. *Engineering*, after describing the battle, continues: "Thus ended the battle of Manila, if battle it can be called, where on one side hardly a man was hurt. However glad one may be that those who speak our mother tongue met with so little disaster, one cannot but sympathise with the devoted Spaniard."

This "damning with faint praise" seems like the regret of a covert enemy rather than the cordial felicitation of a sincere friend. The American nation is satisfied with that battle. No one rejoices over a fallen foe: but we cannot forget that Spanish devotion above applauded would have more effectively secured that Monarchy had seasonable preparations been made to defend the shores, the surrender of which, undefended, only served to humble Spanish pride.

tion of affairs was perfectly understood by the Spanish artillery, one of whose principal officers, ordered to place the antiquated or obsolete guns and carriages in a condition for vigorous defence, committed suicide in despair. Well might the *Heraldo* of Madrid, May 2nd, exclaim "What has been gained by the illusion that Manila was fortified!"

Let us hope that the government of the United States, in its new colonial career, may profit by the fatuous conduct of its recent adversary.

Binang, Laguna Province, Luzon, August 6, 1900.

WM. E. BIRKHIMER,
Captain, 3d Artillery,
Colonel, 28th U. S. Volunteers.

THE SECOND BOER WAR.

V.

The fourth act in the South African war closed with the brilliant campaign of Roberts, ending with the occupation of Pretoria, the Transvaal capital.

Pretoria had been well fortified with seven strong forts, but only five of these had their armament. Fort Signal, about 5½ miles south of Pretoria, commanded the railroad to Johannesburg, and was well armed, and at the outbreak of hostilities fully garrisoned; and Fort Wonderboom, about 5 miles south of the capital, was one of the best of modern forts. The garrisons, however, had been sent into the field, and were never replaced. Moreover, the entire line of defense was too extended for the 10,000 men left to hold it. For these reasons the Boers gave up this important point, and retired to Middelburg on the railroad, leaving a strong rear-guard at Hatherley, 12 miles east of Pretoria.

They had decided to defend the mountain district of Lydenburg, and had for some time been sending daily from Pretoria 50 trains with supplies into this region. Nevertheless, they had not yet made up their minds to limit themselves to guerilla warfare, but proposed to make a stand at any good available defensive positions, such as Hatherley, Middelburg and Volksrust.

In the northern part of the Orange Free State their resistance was not yet subdued, but there guerilla warfare was exclusively adopted, and proved effective.

EVENTS IN ORANGE RIVER COLONY.

Lord Roberts reached the end of his march with about 25,000 men,—10,000 cavalry and 15,000 infantry, so that he still had enough to cope with Botha, and had reason to hope that Buller and Hunter could advance to Pretoria. But the great danger was that threatening his lines of communication, especially as Buller's advance was too slow to enable him to count on a line through Natal in time, and to dispense entirely with the line through Kroonstad.

Roberts took with him into the Transvaal about 46,000 men. Hunter, Mahon and Plumer had about 11,500. In Orange River Colony there were about 41,500.

His immediate army comprised Pole Carew's (11th) division, Smith-Dorrien's brigade of Colville's division, and Maxwell's of Tucker's division; also French's cavalry, and Hamilton's mounted infantry.

The following troops had been assigned to the protection of the lines of communication in rear of Robert's army, viz.:

1st division, Lord Methuen, on the Rhenoster (Paget's Brigade at Lindley).
3d division, Chermside, near Senekal.
6th division (½), Kelly-Kenny, at Bloemfontein.
8th division, Rundle, at Hammonia.
8th division, Colville, at Heilbron.
Colonial division, Brabant, at Ficksburg.

West of Johannesburg the detachments of Hunter and Colonel Mahon had joined forces at Ventersdorp. Troops from Cape Colony and half of Kelly-Kenny's division (Maxwell's brigade from Johannesburg) had been sent to Kroonstad to strengthen the line of communications.

Buller in Natal had Clery's, Lyttleton's and Warren's divisions, as well as three Natal cavalry brigades.

The Boers were still about 27,000 strong: 10,000 at Hatherly—Middleburg (east of Pretoria), 8,000 under Stein at Heilbron—Bethlehem—Harrysmith—Ficksburg—Vrede, 9,000 at Laings Nek.

De Wet, who had retired into the Elandsberge, between Lindley and Francfort, soon began to display great activity. Utilizing the difficult mountain district as his base, he made constant forays against the railroad between Kroonstad and Vereeniging. In the early part of June he succeeded in destroying the telegraph line and the railroad near Roodeval and American Station, for a distance of 20 miles.

The advance of Methuen from Lindley towards Heilbron, and of the troops of the Lines of Comunication under Lord Kitchener from Vereeniging, prevented their gaining a permanent foothold, but constant forays were made against this long line of railroad. Lord Kitchener joined forces with Methuen at Heilbron, and the united forces marched to the Rhenoster River, where they completely defeated De Wet, and then marched to Kroonstad. During the repair of the road between Roodeval and American Station the Boers captured a number of workmen, detachments of troops, convoys, and in one case even an entire battalion,—the 4th of the Derbyshire militia regiment. The Boers were especially active against Honing Spruit Station. Whenever successful they retired to their fortresses in the Elandsberge.

On June 19th De Wet with 5000 men attacked Methuen's force, escorting a transport train to Heilbron, but was defeated. Nevertheless, on the 23rd he cut off a British detachment on the Kroonstad—Honing Spruit Section, attacked the camp of the Shropshire Regiment and the Canadian Contingent, captured a train going south, tore up the track for some distance, and only retired before superior forces coming from Kroonstad.

In the vicinity of Ficksburg, where General Brabant had remained, and at Hammonia, whither Rundle was hastening in support, the Boers under De Villiers were also active. In the middle of June, Brabant disarmed a Boer commando of 1500 men near Ficksburg, but the Boers received considerable reinforcements from the northern part of the Orange River Colony. President Steyn had moved his seat of government to Bethlehem, so as to be between De Wet and De Villiers, in order to incite both to desperate and constant resistance.

These engagements have no effect on the general situation, and the fact remains that a large part of the inhabitants of the Orange River Colony have retired to their farms, leaving the forces in the field too weak to accomplish anything decisive.

EVENTS IN NATAL.

The advance of Buller in Natal, against the extremely strong position of the Boers had been necessarily slow, so that he was not able to take part in the proposed concentric advance on Johannesburg. His efforts were directed to turning the Boer position, and in this he showed that he had learned well the lesson of the Tugela.

His attempt to turn the Boer left flank, by detaching Lyttleton to Vryheid and Hildyard to Utrecht, failed. His next step was to secure favorable artillery positions to command Majuba Hill and Laings Nek, operating against the right flank of the Boer position.

The advance of Lord Roberts to Johannesburg had had its effect on the Boer troops, and their forces, previously given at 10,000, were considerably reduced. Their leader, Christian Botha, had asked for a three days cessation of hostilities, but Buller's demand for unconditional surrender ended the correspondence.

On June 3d Buller resumed his advance, his plan being to hold the Boer front and to roll up the flanks. For this purpose he made a reconnoissance over Botha Pass toward Gansvlei Spruit, a branch of the Klip River, and then assembled his forces behind his left wing for a decisive attack.

Meanwhile Lord Stratcone's Horse (from Canada) was sent out to the north to threaten the rear of Botha's force, and his railway communications with Delagoa Bay over Komati Poort.

General Coke, with the 10th brigade and the South African Light Horse, took the Van Wyk Berg, a spur of Mount Prospect, with little loss; and in the night of the 7th the Van Wyk Berg and the southwestern spurs of the Inkwolo Berg were occupied by artillery. Under the protection of the fire of the latter, General Hildyard on the 8th attacked the heights between the Inkwolo and Bothas Pass and carried them in excellent form, winning thereby his promotion to Lieutenant General. Almond's Nek, the last pass before Charlestown was taken, and the road to the enemy's rear was opened.

On the 9th Buller resumed the offensive, moving in the direction of the Gansvlei valley, pushing along the Transvaal and Natal border in a northeastern direction, to turn Laings Nek. The Boers in his front retired towards Paardekop, and on the 11th of June, after the further advance of the British on Volksrust, the Boers (3000), occupying Laings Nek and Majuba Hill, abondoned this strong position, retiring on Wakkerstrom. They were thus separated into two parts, but in spite of the success of Buller's strategical maneuvers, the Boers were enabled to retire without loss, taking their artillery and train with them.

On June 12th Buller, on account of the scarcity of water, retired from Volksrust to Charlestown, where he joined Clery, who had come from Ingogo.

The interruption of the railroad at Laings Nek was soon repaired, and by the 17th of June the first train was running through this point.

On the 19th Lord Strathcone's Horse (sent out about the 9th) destroyed a railway bridge near Komati Poort, cutting Botha's communications in that direction.

EVENTS IN THE TRANSVAAL.

FIRST CAMPAIGN AGAINST LOUIS BOTHA.

Reconnoissances from Roberts' main army at Pretoria had established the fact that Louis Botha's army was at Eerste Fabriken (Hatherley and Donkerholk), about 16 miles east of Pretoria, on both sides of the Middleburg road. The position was a strong one but too extended for the troops occupying it,—about 12,000.

In spite of the fact that everything was quiet and peaceful in Pretoria and Jonannesburg, the close proximity of so strong a Boer army was a constant menace, and Roberts decided to attack it. Reinforcements could not be expected for some time, as

Buller was still at Laings Nek, Hunter at Potschefstroom, Baden-Powell at Rustenburg, and no troops could be spared from the line of communications. He therefore decided to make the attack with what troops he had in hand.

The Battle of Diamond Hill.

Botha had concentrated his forces on the flanks of his position, leaving the center comparatively weak. Roberts, following his usual course, advanced on the 11th of June with a broad front, intending to enclose the Boers with both flanks, French's cavalry division on the left to turn the Boer right flank, Hamilton, with the mounted infantry and Broadwood's brigade on the right, to turn the Boer left, while Pole-Carew, with some mounted infantry, under Colonel Henry, held the enemy at the center. Roberts, however, soon found Botha's flanks too strong, and directed his efforts on the center, ordering Hamilton to attack Diamond Hill, which was accomplished with little loss on the 12th by the aid of Pole-Carew's division, the Boers retiring towards Middelburg. The British troops did not pursue, but returned to Pretoria.

Roberts decided to await the arrival of reinforcements before inaugurating a definite campaign against the forces in northern Orange River Colony, threatening his line of communications. With this object in view, he drew in the Natal army along the Laings Nek–Johannesburg railroad, to separate completely the Transvaal and Orange Boers, Buller reached Standerton on the 17th, and Hunter turned off at Krügersdorp (west of Johannesburg) towards Frankfort. Baden-Powell reached Pretoria on the 18th. On the 21st Buller reached Paardekop, Hamilton's column from Pretoria reaching Springs on the same day, ready to join hands with Buller at Heidelburg on the 24th of June, but Buller was forced to halt at Standerton, which he reached on the 23rd, because the Boers had destroyed the bridge there, and their forces to the eastward threatened his line of communications.

EVENTS IN ORANGE RIVER COLONY.*

Roberts, towards the end of June, directed his attention to the Boers under Steyn and DeWet, threatening his line of communications. The enveloping movement already begun was gradually completed.

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* In Cape Colony, on June 23d, De Villiers' commando, 200 men, 280 horses, 18 wagons, 260 rifles, and over 100,000 rounds of ammunition, arrived at Blikfontein and surrendered to Sir Charles Warren. De Villiers in person escaped eastward.

A glance at the general situation at this time will aid materially in comprehending the movements about to follow:

Baden-Powell, Hutton and Plumer held Rustenburg; Pole-Carew, Tucker and French formed the garrisons of Pretoria and Johannesburg; Smith-Dorrien was at Vredefort (southwest of Johannesburg), to guard the west of the railroad; Methuen, Knox, Kelly-Kenny, Clements, Paget, and Colville were stationed at Rhenoster, Kroonstad, Bloemfontein, Senekal, Lindley and Heilbron, respectively, to guard the railroad on the east; Rundle and Brabant completed the cordon along the north-west border of Basutoland, at Hammonia and Ficksburg, respectively; Hamilton and Hunter occupied Heidelberg; and Buller had reached Standerton.

The Boers, still numbering 20,000, had about two thirds of their forces south of the Vaal, divided into four commandoes, under Piet and Christian DeWet, Lemmer and Olivier.

Buller, after occupying Standerton, sent mounted troops forward to Greylingstad. Viljeon's commando, which had held the place, retired towards Middelburg. Buller had left a strong detachment under Hildyard, at Volksrust and Laings Nek to guard the pass and railroad against any efforts of the Boers who had retired from that point on Wakkerstroom. During his advance his outposts had met numerous small bodies of Boers, indicating the presence of the latter on all sides. A Boer force of 1000 from Wakkerstroom took up a strong position at Gras Kop, north-west of Volksrust, and fifteen miles from Sand Spruit Station, threatening the railway line.

On June 29th, General Coke, sent on a reconnoissance with the 10th brigade to Amersfoort (12 miles north of the railroad), discovered a force of 2000 Boers with guns in a strong position there, which he did not attack. In view of these facts, Buller strengthened his outpost at Greylingstad with a brigade on July 3d, and early in July pushed out Clery to the vicinity of Heidelberg, where he joined Hart's brigade on the 4th. Thus, it is evident that nearly all of Buller's troops were needed to guard the railroad. However, on July 7th he reported that the railroad was serviceable as far as Pretoria.

Buller's position along the railroad completed the separation of the Orange from the Transvaal Boers and brought his forces in contact with those of Roberts.

The Campaign Against De Wet.

As soon as Roberts had organized his cordon around the Orange Boers, and had completed their separation from the Transvaal

Boers, he proceeded to institute a decisive campaign against De Wet, ensconsed in the Elandsberge, whence he had made numerous successful sorties against the troops guarding the lines of communication.

The general movements were inaugurated on July 1st by sending Hunter (exclusive of Hart's brigade, which was left at Heidelberg), as well as Broadwood's and Little's cavalry brigades, to Frankfort.

As soon as these troops were in position, the following changes in organization and command were instituted:

Colvile's division (9th) was broken up, and its commander relieved; Macdonald's (Highlander) brigade being assigned to Hunter's (10th) division, in place of Hart's, joining Hunter on July 3d in Frankfort; Smith-Dorrien's being transferred to Methuen's (1st) division, then at Paardekraal, north of Kroonstad, the latter sending Paget's brigade to operate against De Wet. Broadwood's and Little's brigades, first attached to Hunter's division, were now attached to Paget's brigade, which was to constitute Hunter's advance guard. The mounted infantry, which had been sent from Robert's immediate command, reached Heilbron on the 8th of July, but was afterwards called back to relieve Methuen on the lines of communication, when the latter was sent on July 11th to the relief of Rustenburg.

The general plan was a concentric advance of Hunter from Frankfort, Paget from Kroonstad, and Clements from Winburg, against De Wet, in order to surround and capture him in the mountains near Lindley.

Paget moved rapidly, reached Pleiserfontein, east of Lindley, on July 3d, and had an engagement with the Boers there. The latter were defeated and followed by Paget on the 4th to a point half way between Lindley and Bethlehem (the temporary seat of the Orange Boer government, which was now moved to Reitz). De Wet had taken up a strong position at Bethlehem, consequently Paget hesitated to attack him, and decided to await the arrival of Clements. On the 7th their combined forces continued the advance, and compelled the Boers to retire into the mountains south of Bethlehem.

Meanwhile, Broadwood and Little arrived at Bethlehem, while Hunter was still on the march from the north, some distance away. The original concentric advance of three columns had thus become the simple advance of a single column.

De Wet, after retiring into the Roode Berge south of Bethlehem, found himself between the forces at Bethlehem and the

Basutoland border, threatened in his left flank by Brabant and Rundle, and cut off in the west.

Meanwhile, Rundle and Brabant continued their advance, reaching Rooikrans (north-west of Ficksburg), where they drove off a small Boer detachment, and establishing the fact that a strong Boer force was posted east of that place.

On July 16th, meeting with little resistance, De Wet was enabled to break through the left flank of Rundle's line, with 1500 men and 5 guns, marching on Lindley.

Broadwood and Little (from Bethlehem, where Bruce Hamilton had now arrived) followed in pursuit, and struck De Wet on the 19th at Palmietfontein, just west of Lindley, and defeated him. But on the 22nd he turned up at Serfontein, just north of Honing Spruit, took a transport train with its guard (1 officer, 100 men), continuing his march to Vredefort, where he halted on the 23rd and prepared his position for defence.

The Boers again displayed considerable activity at other points. A reconnoitring party with a battery, sent out from Bethlehem by Hunter on July 21st, came upon a strong position held by Boers about 20 miles west of Bethlehem, and was forced back. On the 22nd minor engagements took place with Boer forces south of Bethlehem, and on the 23rd Hunter moved out with stronger forces, but failed to carry the Boer position on that day. On the 24th, however, he succeeded in turning the Boer flanks, the latter retiring before him. He moved south in pursuit, reaching Fouriesburg on the 27th.

Meanwhile, Rundle continued his advance, pushing the retiring Boers in his front before him towards the same point. He occupied Kommandonek, and the two forces of Boers found themselves between Hunter and Rundle. The result was that Prinsloo with about 4,140 men surrendered on July 30th. Among the captured were commandants Villiers and Crowther, and three other commandants of less note. General Olivier, with his commando and five guns, however, succeeded in breaking through in the direction of Harrismith.

EVENTS IN THE TRANSVAAL.

The renewed activity of the Boers was made evident not only along Roberts' line of communications, but also on his immediate front and flanks. The flanks of the British army at Pretoria were covered by detachments at Rustenburg (50 miles west of the capital), near Bronkhorst Spruit (35 miles east) and at Springs (the terminus of the branch line from Johannesburg), and at all these points, as well as at others, the Boers made more or less energetic attacks, besides that already referred to at Greylingstad.

Actions at Rustenburg and Olifants Nek.

On July 8th, Lemmer with a commando of Boers suddenly appeared before Rustenburg, occupied the heights commanding the town, and demanded its surrender. Major Tracy, in command there refused, and opened an attack on the Boers. Part of Carrington's force from Zeerust arrived in time to take part in the action, and Lemmer was forced to give up the siege and retire. A few days later, however, after this relief force moved on to join Lord Roberts, the Boer leader Delarey appeared before Rustenburg and resumed the siege. The garrison was too weak to resist him for any length of time, so Roberts, to relieve his threatened left flank and restore communication with Mafeking, was forced to draw Methuen from Paadekraal (north of Kroonstad) to Rustenburg. The latter reached on the 21st the vicinity of Rustenburg over Krügersdorp, struck the Boers at Olifants Nek, and dispersed them.

Lord Roberts had at this time decided on a grand right wheel of his army, advancing on Middelburg, and Methuen was left at Rustenburg to cover his rear. But on the 25th he was ordered to march over Potchefstroom towards the Vaal, to join Broadwood and Little against De Wet, who had intrenched himself at Vredefort.

In Roberts' immediate front the army of Louis Botha had again grown to a strength of 15,000 men, and had taken up its position at Bronkhorst Spruit, 35 miles east of Pretoria.

Action at Springs.

Colonel Mahon had occupied with his own troops and portions of Hamilton's mounted infantry, which had been left in the Transvaal, the important end station, Springs, on the Johannesburg branch. He was the first to feel the pressure of this strong Boer army in such close proximity to Roberts' front. On July 6th about 3000 Boers attacked his position, and could only be forced back over the Bronkhorst Spruit after a hard fight on the 7th. But this attack was evidently merely a diversion to cover a more determined advance of the Boers by the north and west of Pretoria to act on the flank of Roberts' line and gain touch with the Boers around Rustenburg.

Action at Uitvals Nek.

In anticipation of such a movement Roberts had sent five companies of the Linconshire Regiment, and a squadron of Scots Greys, with several guns, to occupy Uitvals (Massilikatz) Nek, a pass about 18 miles west of Pretoria, to cover his left flank. These troops reached their destination on July 10th, and occupied a position directly covering the pass with three companies, the other two being left on the plain. On the 11th, at dawn, Boers to the north of the pass opened fire on the British outposts, and at the same time a heavy fire was opened by Boers from kopjes to the east of the pass, or in rear of the British. These Boers were part of Delarey's force. The fight lasted all day, and, although reinforcements were sent they arrived too late, the three companies in the pass having been surrounded and captured. The British lost 90 prisoners, besides the killed and wounded. The latter amounted to 1 officer and 15 men killed; 3 officers and 51 men wounded.

Action at Derdepoort.

On the same day, July 11th, Roberts' outpost at Derdepoort (5 miles north-east of Pretoria) was surprised and attacked by the Boers under Delarey, resulting in the retreat of the British with considerable loss, viz.: 1 officer and 2 men killed; 2 officers and 4 men wounded; and 19 men missing.

Another Boer subdivision occupied a ridge running east and west, about 10 miles north of Pretoria, but retired before a strong detachment* sent out by Roberts on July 16th, since it had accomplished its object of drawing British troops in that direction, in order to prepare the way for a direct attack on Roberts' front.

The latter was directed on Pole-Carew's left flank and the left wing, commanded by Hutton, but the excellent handling of the British artillery resulted in the defeat of the Boers. An attack on the Springs, at the same time, was repelled by the fire of the Royal Irish regiment.

Numerous sallies were also made against the British detachments at Krügersdorp.

All these operations of the Boers indicated their presence on all sides of Roberts' army, and demanded some decided action at once.

Campaign of Middelburg.

Second Campaign against Louis Botha.

Roberts determined to move against the strongest and most active of the Boer armies, namely that of General Louis Botha, in the direction of Middelburg.

On July 19th, the movement began. The British line was formed just east of Pretoria facing eastward: French on the right

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* A new brigade under Colonel Cunningham was formed, comprising 1st battalion King's Own Scottish Borderers, 1st battalion Royal Berkshire Regiment, 1st battalion Argyll and Sutherland Highlanders. Hickman's mounted infantry (1800) was attached.

at Treneestate, Pole-Carew in the center, Hutton's mounted fantry on the left, including Hamilton's mounted infantry Mahon's brigade, which had been sent to Springs.

The British forces numbered about 22,000; the Boers about 12,000 men in position.

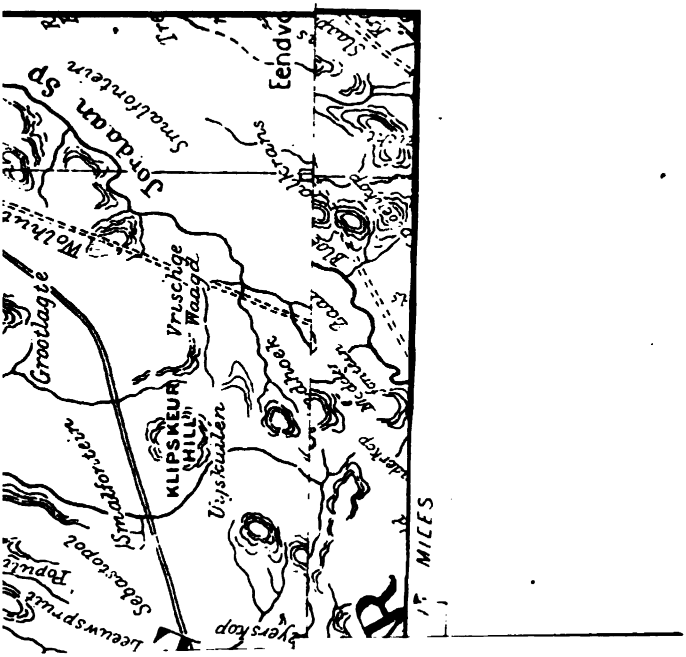
He first moved along the railroad to Bronkhorst Spruit; d ing the advance Hutton was sent to reinforce French's ri wing, while Hamilton's and Mahon's mounted infantry mo to the left flank behind Pole-Carew's division.

On July 22nd the right wing was south of Prinsloo, on t Bronkhorst Spruit, its center at the station; the left flank Russfontein (6 miles north of the station); giving Pole-Carew very advantageous position at the center. On the 23rd, wh the general advance began, the Boers retired eastward. Fren reached the eastern shore of Wilge River, 7 miles south of B moral Station (5 miles east of Wilge River Station), on the aft noon of the 24th; the leading brigade (Stephenson's) of P Carew's division arrived at the Elands River station (30 mi east of Pretoria); while Hamilton remained about 8 miles rear, as a left flank guard. The Boers had offered no resistan at any point.

On the eastern shore of the Wilge River, however, Fren found a Boer commando of 2000 Boers ready to resist his advanc Part of Hutton's mounted infantry attacked the right flank the position, while French endeavored to pass around the le flank. The Boers retired, and French and Hutton pursued, b failed to get any material results.

On the 25th, the center reached Balmoral Station, 10 mil east of Elands River. French and Hutton continued the pu suit over the Steenkoot River, where the condition of their hors compelled them to halt. A few detachments crossed the Olifan River, and reported strong columns of Boers in full retreat o Middelburg. The weather was very inclement, the rain fallin in torrents, and a cold east wind blowing. This, together wit the condition of the horses, prevented Roberts from taking ad vantage of the situation.

Roberts in person, and the troops of Hamilton and Mahon returned to Pretoria, which they reached on the 30th. Frenc and Pole-Carew (their forces amounting to about 15,000 men continued the pursuit as far as Middelburg where they arrive on the 29th. Louis Botha withdrew into the hills of Wonderfon tein with his main army, leaving a considerable force on th



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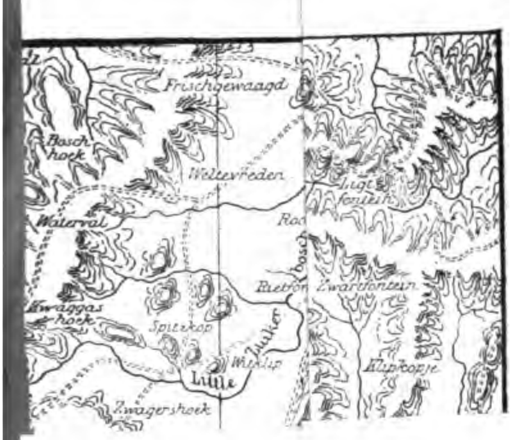
Eendvo
Wolhut
Vrischge Waagd
Grootlagte
KLIPSKEUR "HILL"
Uijskuilen
Sebastopol
Populi
Leeuwspruit
Kalkkraans
Zoek
MILES

Bosch hoek
Waterval
Kwaggas hoek



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Bosch hoek
Weltevreden
Ligt fontein
Waterval
Roo
bosch
Rietfon
Zwartfontein
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Spitzkop
Zuiker
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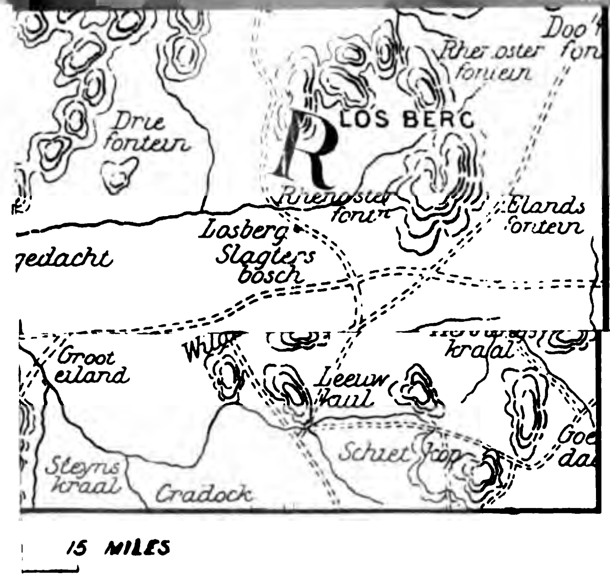
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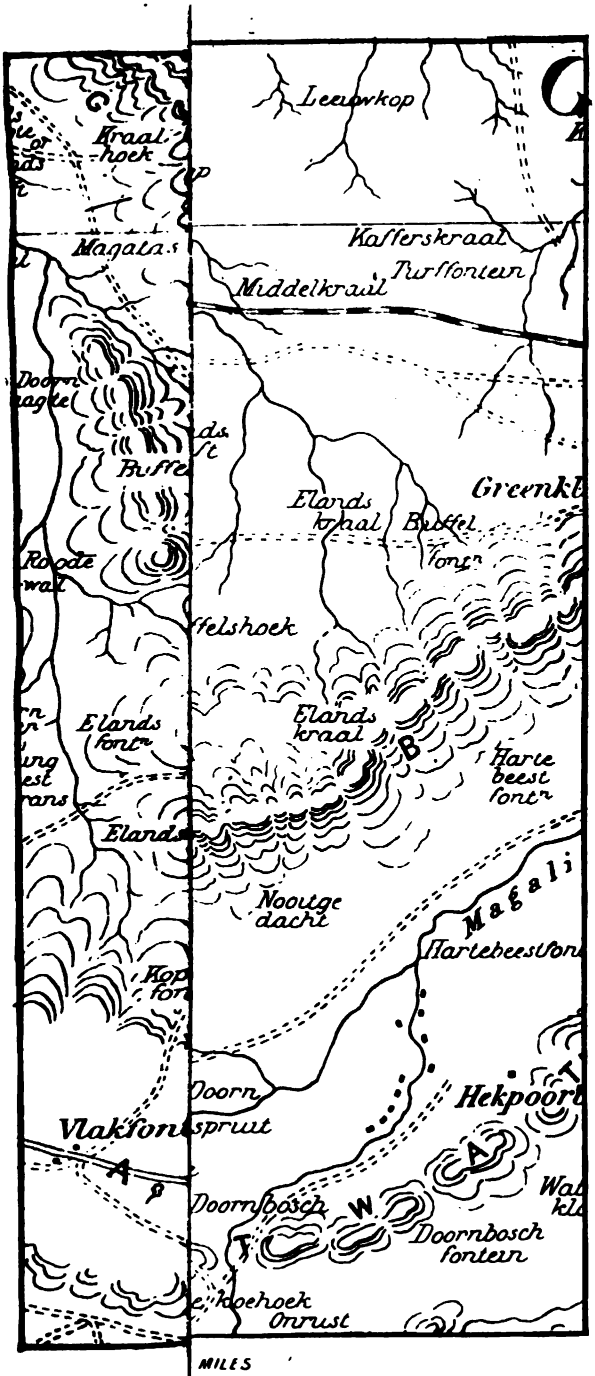
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Kraal hoek
Kafferskraal
Turffontein
Magalas
Middelkraal
Doorn
Buffel
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Harte beest fontn
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Elands
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Magali
Hartebeestfon
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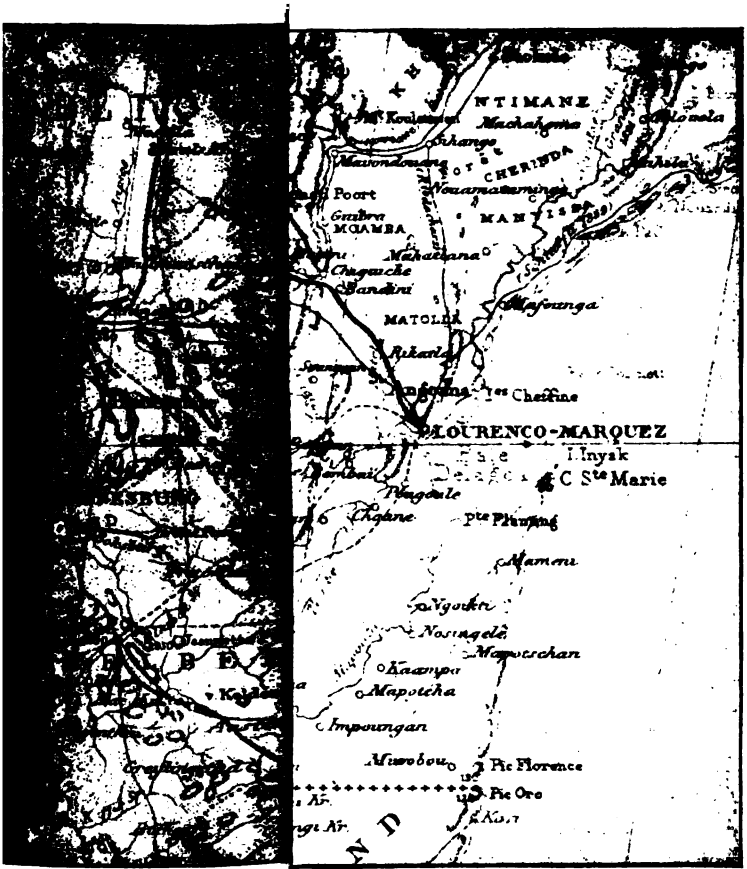
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Machahgma
Mavondouane
CHERINDA
Poort
MOAMBA
MANTISE
Mahatana
Chigwiche
Bandini
Mafounga
MATOLLA
Rikatla
1es Cheffine
LOURENCO-MARQUEZ
I. Inyak
C Ste Marie
Pongoule
Chgane
Pte Planting
Mamem
Nosingele
Mapotschan
Kaampa
Mapotcha
Impoungan
Muvobou
Pic Florence
Pic Oro
Kosi

Bothas Berge, north of Middelburg, threatening the left flank of any further advance eastward on the part of the British.

Meanwhile, Buller (who had previously moved from Standerton back to Paarde Kop, to be nearer Hildyard, who was constantly threatened by the forces under Christian Botha near Volksrust) sent Littleton and two cavalry brigades to threaten the Boer left flank east of Middelburg, these troops reaching Amersfoort (25 miles north of Volkrust) on the 5th of August. Clery was left to guard the railroad between Standerton and Heidelberg, Hildyard near Volksrust.

Botha at first retired before Buller, but finally made a stand on a ridge north of Amersfoort.

On August 6th the British attacked the position: Dundonald on the west side, the infantry on the east; the latter, with the Kings Royal Fusiliers on the right, and the Gordon Highlanders on the left, continued the attack, in spite of the heavy artillery fire, till 5 P.M., when the Boers retired. The roads were so bad that the train was far to the rear, consequently Buller was compelled to remain in Amersfoort on the 7th.

On the 8th he continued his advance, reaching Rood (on the Vaal) on the 9th, and on the 12th Ermelo, in rear of the forces of Christian Botha, who were retiring on Carolina. On the 15th he reached Twyfelaar, near Carolina. Meanwhile, French's reconnoitring parties from Middelburg over Wonderfontein had established communication with Buller.

The Boers made several attempts on Buller's line of communications. In the vicinity of Ingogo, south of Laings Nek, they brought a heavy gun into position with a view to destroy the iron railroad bridge there; near Ladysmith they made several efforts to break up the railroad; and finally, on August 21st, a Boer detachment destroyed the bridge 9 miles north of Newcastle, and broke up the railroad south of that point. West of Standerton also there were constant skirmishes with Boer detachments.

These interruptions caused Buller to delay his further advance.

The Chase After De Wet.

De Wet had intrenched himself in the vicinity of Vredefort, whither he had been pursued by Broadwood and Little. Methuen had been ordered down from Rustenburg over Potchefstroom, to take part in the pursuit of De Wet.

This Boer leader with his small column, with which was also President Steyn, was considered of such importance that Lord

Kitchener was ordered to take the troops from Springs, reinforce Broadwood and Little, and conduct the operations, but Methuen was not placed under his orders, the latter retaining independent command of his own column from the north-west.

De Wet remained inactive from the 23rd of July to the 7th of August, awaiting the approach of Methuen from Potchefstroom, and Kitchener, operating south of the Vaal. On that day, however, he marched his main column to Lindequees Drift, 20 miles up stream from Vredefort, and protected himself against Kitchener, sending a flank column over the Vaal at Venterskroom, 7 miles north-west of Vredefort, to cover his position against a flank attack by Methuen, which might impede his passage of the river. This flank column, on the morning of August 7th, had an action with Methuen's advanced troops, but retired in good order, reaching Buffelshoek, 7 miles north-east of Venterskroom, on August 9th (the day on which Lord Kitchener reached Lindequees Drift, and had a slight engagement with De Wet's rear guard), and was attacked again by Methuen. Neither British commander knew of the near presence of the other until the fighting at Lindequees Drift on the one hand, and Buffelshoek on the other, informed them, otherwise Methuen would have moved by his right, joined hands with Kitchener, and then rolled up De Wet's flank. De Wet drew his forces on the 9th from the two rear guard actions, combined his forces, and retired on Welverdiend, 18 miles north-east of Potchefstroom, whereas Kitchener and Methuen did not join forces till the 10th, north of Buffelshoek.

At Welverdiend, however, De Wet found Smith-Dorrien, whom Lord Methuen had left behind to guard the railroad, and who now blocked his way northward. He had little difficulty, however, in slipping by these troops, following the Mooi River towards Rustenburg.

Kitchener and Methuen, moving in two separate columns, overtook De Wet again on the 13th of August east of Ventersdorp, Methuen succeeding in capturing one gun. On the night of the 13th De Wet liberated his 60 British prisoners, blew up three ammunition wagons and abandoned 30 worn-out horses, and escaped from his pursuers.

On August 17th De Wet reached Kommando Nek in the Magalies Hills, between Pretoria and Rustenburg, and came here upon Baden-Powell, who happened to have withdrawn to this point, for reasons which will be at once explained:

The British had posted three detachments to guard the line from Mafeking towards Pretoria, viz.: Carrington (who had come through Rhodesia and taken part in the first relief of Rustenburg) at Zeerust; Lieutenant-Colonel Hore, with 400 men at Elands River, 40 miles west of Rustenburg, and Baden-Powell, with 4,000 men, at the latter place, where he had been twice besieged and relieved, and was still constantly threatened by Delarey (who had recently been reinforced by Grobler's commando).

As soon as Methuen left to operate against De Wet, Rustenburg was besieged for the third time, and this explains why Lord Roberts brought Hamilton's and Mahon's mounted infantry back from the campaign against Middelburg. Hamilton left Pretoria on his way to relieve Rustenburg on August 2nd, and succeeded in joining Baden-Powell, Delarey retiring without resisting. Hamilton brought Baden-Powell to Kommando Nek, where the latter intrenched himself, and himself started southward to take part in the chase after De Wet, reaching Blaauwbank on August 13th.

No sooner was Rustenburg abandoned than Delarey turned on the weak garrison of Elands River and besieged it. Carrington, with 900 men and several guns started out from Zeerust on August 3rd to relieve Hore, but on the 5th, as he was approaching Hore's camp, he found his way impeded by a strong Boer force with artillery. He was forced to retire, under heavy cross fire, and reached Zeerust, after considerable loss in men and material on the 7th; but at once decided to retire still farther. On his way to Mafeking he met another force of Boers at Ottoshoop and Malmain on the 16th of August, and had a skirmish with them, but drove them off.

Hore was thus entirely isolated after August 6th. On the 10th a messenger from Hore came through the Boer lines and reported the garrison still resisting. Roberts received this message on the 13th, and at once ordered Carrington and Hamilton to return to the relief of Hore. Meanwhile, Kitchener, who saw the uselessness of further pursuit of De Wet, and hearing of Hore's dilemma, also started to his relief, reaching Elands River on August 16th, the Boers retiring northward. Methuen, giving up the pursuit of De Wet in the vicinity of Rustenburg, started westward to the region about Zeerust, Mafeking and Lichtenburg, to restore order at points threatened by the Boers.

When Hamilton on the 17th approached Rustenburg he learned of the relief of Elands River, and also of the near presence of De Wet, who, after calling upon Baden-Powell at Kommando

Nek to surrender, had continued his march on the 18th towards the Sterk Stroom north of Rensburg. Hamilton had reached Olifants Nek, south of Rustenburg, on the 17th, and Mahon, his advance guard, came in touch with De Wet. Hamilton decided to continue the pursuit; meanwhile Baden-Powell, moving towards Rensburg on the Pretoria–Rustenburg road, attempted to strike De Wet's flank. On the 19th, while Baden-Powell continued his turning movement, Mahon succeeded in engaging De Wet's rear guard in an action on the Crocodile River, but the latter escaped, and on the 20th camped near Hebron, 20 miles north-west of Pretoria.

It looked as if De Wet was aiming to cross the railroad north of Pretoria and join Louis Botha's forces.

Roberts, meanwhile, had sent Paget on the 18th of August along the Pretoria–Pietersburg road northward, and the latter, after forcing small Boer detachments out of the Horne's Nek (10 miles north-west of Pretoria), had taken up a position near Hamannskrahl (27 miles from Pretoria). On the 20th Roberts also sent Clements northward to take part in the pursuit of De Wet. Baden-Powell, turning out of the Pretoria–Rustenburg road completed the line around De Wet.

On the 20th, Paget allowed himself to be drawn into a fight by a detachment of De Wet's, and was held fast all day; and on the 21st, Baden-Powell struggled all day against the rear-guard of Grobler (part of whose forces had joined De Wet). Meanwhile, De Wet accomplished the main object of his long and dangerous march, viz.: to enable President Steyn (with a strong detachment) to escape eastward over the Pienaars River to join Krüger in Machadodorp through the unoccupied region over the Bothas Berge. De Wet himself, with a small force, turned back over the Magalies Berge to regain the Orange River Colony.

The force under Methuen remained in western Transvaal, while Paget and Baden-Powell took charge of the Pretoria–Pietersburg railroad.

Hamilton's division was taken by Lord Roberts on the new campaign against Botha.

THE SITUATION IN THE ORANGE RIVER COLONY.

The capitulation of Prinsloo at Fouriesberg, the escape of De Wet northward, and that of Olivier eastward, were the events that marked the end of July in this region. Macdonald, who was pursuing Olivier, reached Harrismith, which yielded without resistance; Hunter remained at Bethlehem, while Rundle also advanced to Harrismith, to secure the Ladysmith–Bethlehem railroad, which was now placed in operation.

Small Boer commandoes still infested the district, however, and as early as August 2nd one attacked the line at Rhenoster Spruit, compelling Knox to move out against it from Kroonstad; while another derailed a train at Honing Spruit (south of Kroonstad). These disturbances were all the more difficult to control as the British forces had been greatly reduced by the removal of Broadwood, Little, Paget and Clements, who had gone in pursuit of De Wet.

Towards the middle of August, Olivier suddenly appeared south of Heilbron. Hunter moved out against him from Bethlehem and was joined by Macdonald. They attacked Olivier on August 15th, but failed to capture him, or prevent his escape, and lost touch with him in the pursuit. Soon after, Olivier fell upon a British post at Ventersburg, inflicting a loss on the British of 2 killed and 5 officers and 24 men captured. On August 25th he attacked Winburg from three sides but was defeated by Bruce Hamilton, and, with three of his sons, was made prisoner.

Soon after, a Boer commando appeared before Ladybrand and threatened the town.

These disturbances, evidently intended to keep the British forces divided, decided Roberts once more to institute a decisive stroke against the main Boer army east of Middelburg.

APPENDIX.

OFFICIAL TABLE OF CASUALTIES.

June 19, 1900.

Casualties in Action.	Killed.		Wounded.		Died of wounds in S.Africa (included in wounded).		Missing and prisoners.		Total killed, wounded, missing, and prisoners.	
	Officers.	N. C. O.'s and men.	Officers.	N. C. O.'s and men.	Officers.	N. C. O.'s and men.	Officers.	N. C. O.'s and men.	Officers.	N. C. O.'s and men.
Belmont, Nov. 23	3	50	25	220	1	21	—	—	28	270
Colenso, Dec. 15	7	128	43	719	2	20	21	207	71	1054
Driefontein, March 10	5	58	19	342	1	18	—	2	24	402
Dundee, Oct. 20	8	40	11	84	3	—	25	306	44	430
Elandslaagte, Oct. 21	5	50	30	169	—	6	—	4	35	223
Enslin (Graspan) Nov. 25	3	13	6	163	1	3	—	9	9	185
Farquhar's Farm and Nicholson's Nek, Oct. 30	6	57	9	244	—	10	43	925	58	1226
Johannesburg & Pretoria	3	20	34	129	1	6	5	38	42	187
Karee, near Brandfort, March 29	1	20	9	152	1	11	—	—	10	172
Klip Kraal, Feb. 16	—	11	6	101	—	1	—	7	6	119
Ladysmith, Relief of, Feb. 19 to 27	22	241	90	1530	3	75	1	11	113	1782
Magersfontein, Dec. 11	23	148	45	646	3	35	—	108	68	902
Monto Christo, (Colenso), etc., Feb. 15–18	1	13	8	180	—	3	—	4	9	197
Modder River, Nov. 28	4	66	20	393	—	31	—	2	24	461
Paardeberg, Feb. 16–27	17	238	74	1135	6	65	7	63	98	1436
Potgeiter's Drift, Feb. 5 to 7	2	23	18	326	—	8	—	5	20	354
Reddersburg, April 3–4	2	10	2	33	1	1	8	397	12	440
Reitfontein, Oct. 24	1	11	6	98	—	4	—	2	7	111
Sannas Post, March 31	3	16	16	118	2	7	18	407	37	541
Spion Kop, etc., Jan. 17 to 24	27	245	53	1050	6	39	7	351	87	1646
Stormberg, Dec. 10	—	32	7	51	—	1	13	619	20	702
Willow Grange, Nov 23	—	11	1	66	—	2	1	8	2	85
At Ladysmith during investment—										
Battle of Jan. 6	14	167	33	284	4	25	—	2	47	453
Other casualties	6	63	36	280	3	29	—	12	42	355
At Kimberley during investment	2	36	15	118	—	4	1	3	18	157
At Mafeking	5	63	10	147	—	6	1	40	16	250
Other casualties	65	453	215	1786	25	120	49	1,026	329	3265
Total casualties in action reported up to June 9	235	2283	841	10564	63	551	200	4558	1276	17405

Changes in Command.

June. Colonel Carew, 7th Hussars, appointed brigadier general commanding 1st Brigade Rhodesia Field Force, comprising 1st and 2nd Bushmen's regiments. Colonel Grey commanding 2nd Brigade.

Total British Casualties to June 16.

	Officers.	Men.
Killed	243	2.353
Died of wounds	64	558
Died of disease	123	3,782
Died of accidents	....	60
Sent home as invalids	724	15,039
Missing and prisoners*	41	1,469
Total†	24,456	

Changes in Command.

July 1. The 9th division broken up, General Colvile relieved, Macdonald's (Highlander) brigade assigned to Hunter's (10th) division, Smith-Dorrien's to Methuen's 1st division.

Total British Casualties to June 23.

	Officers.	Men.
Killed	250	2,384
Died of wounds	68	589
Died of disease	125	3,985
Died of accidents		66
Sent home as invalids	784	16,358
Missing and prisoners*	37	1,650
Total†	26,296	

Total British Casualties to June 30.

	Officers.	Men.
Killed	254	2,403
Died of wounds	70	610
Died of disease	133	4,204
Died of accidents	....	66
Sent home as invalids	844	18,433
Missing and prisoners*	65	2,624
Total†	29,706	

Total British Casualties to July 13.

	Officers.	Men.
Killed	255	2,411
Died of wounds	70	625
Died of disease	137	4,398
Died of accidents		68
Died in captivity	1	84
Sent home as invalids	916	19,742
Missing and prisoners*	59	1,927
Total†	30,963	

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* Excluding those who have been recovered.

† Excluding sick and wounded now in British hospitals in South Africa.

Total British Casualties to July 27.

	Officers.	Men.
Killed	271	2,502
Died of wounds	73	681
Died of disease	141	4,836
Died of accidents	1	72
Died in captivity	1	85
Sent home as invalids	1044	24,058
Missing and prisoners*	76	2,718
Total†	36,559	

Total British Casualties to August 4.

	Officers.	Men.
Killed	272	2,534
Died of wounds	74	696
Died of disease	145	4,937
Died of accidents	1	77
Died in captivity	1	85
Sent home as invalids	1105	25,049
Missing and prisoners*	59	2,740
Total†	37,775	

Total British Casualties to August 11.

	Officers.	Men.
Killed	272	2,549
Died of wounds	77	712
Died of disease	146	5,036
Died of accidents	1	81
Died in captivity	1	85
Sent home as invalids	1151	26,123
Missing and prisoners*	55	2,768
Total†	39,057	

Total British Casualties to August 18.

	Officers.	Men.
Killed	275	2,560
Died of wounds	78	724
Died of disease	147	5,130
Died of accidents	1	86
Died in captivity	1	85
Sent home as invalids	1151	26,123
Missing and prisoners*	54	2,751
Total†	39,166	

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* Excluding those who have been recovered.

† Excluding sick and wounded now in British hospitals in South Africa.

CAPTAIN JOHN P. WISSER, 7th Artillery,

(To be concluded.)

THE STUDY OF SEA-POWER.

D. Bonamico.

Reprinted from *Marine Rundschau*.

(Continued).

Besides emigration and exportation, national economy also includes commerce, which constitutes the bond between them. Its influence is defined by the following fundamental principles:

1. Commerce constitutes the nervous system, its markets the ganglia of the expansive body; its condition is perfect when its internal structure is well balanced.

2. The disturbance of the balance through excessive or insufficient activity of any member of the internal organization of the expansive body engenders that partial or total diseased condition which is extremely difficult to cure.

3. The prevalence of commerce is almost always an indication of the modern formation of an expansive body, for commerce is generally regarded not as the effect but as the cause of the expansive capacity.

4. The chief commercial problem ought to be to render the advantages arising from expansion useful to the national sway, whilst advantageously opposing foreign competition.

5. Since emigration and exportation are the naturally active elements of expansion, commerce must first of all assure their most efficient reciprocal action before turning to supplementary aims.

6. Since commerce is almost wholly developed by the merchant fleet, the latter must, first of all, satisfy the chief problem, i. e., maintenance of commerce in the domain of national economy.

7. The merchant fleet may strive for its own growth only so far as the latter is indispensable for the execution of the chief problem.

8. The present commercial competition always makes it difficult for merchant fleets and states of the second rank to attain the chief aim without state support.

9. State support is always tendered when the fleet is incapable ofattaining the chief aim with its own recources.

10. The international political situation leads to a removal of theprotection of the markets, thereby calling forth a commercial protective system.

11. The protection of commerce is always less effective than that of the markets, and is made still more difficult and expressive than in the days of sailing vessels by the new relations of steam navigation.

12. However oppressive commercial protection may be, it becomes a duty, whenever it may be expected to maintain thereby the advantage of the expansion of the national domain.

13. In battle, the artificially raised fleets will almost always be overpowered by those endowed with natural strength ; in this case, the injuries due to free trade may be less than those due to an oppressive protective system.

14. The injuries arising from free trade may be diminished through the regulation of emigration, exportation and commerce; if, however, the markets lack protection, it becomes rather doubtfull whether this regulation would suffice to preserve the fleets lacking a natural vitality from a serious crisis.

15. Since the vitality of modern fleets is derived from the iron industry and from the thermal energy of the fuel, the latter constitute the decisive elements in competion and commerce, and can only be counter-balanced through military and political protection.

16. In view of the modern relations in seamanship, it is the inexorable tendency of the universal market to accord with those maritime interests which, in consequence of free competition, attain the monopoly of commerce.

17. The protection of the markets must again, as formerly, be a bulwark of the economic expansive capacity for those nations which are incapable of enduring commercial competition.

The influence of national economy upon sea-power is so great, that we have not hesitated to analyze, somewhat in detail, the foundations of its activity, however much these may be opposed to an hypothesis which reflected on the old economic learning.

History and experience, more even than the study of economics, have suggested to us the principles which determine economical expansion. Naval officers who, in consequence of their constant touch with colonies, markets and fleets have an expert opinion in this matter, will not, perhaps, regard our effort to formulate the principles of economics in their relation to expansion over sea, as inopportune and useless.

b. POLITICS.

The internal dynamics of sea-power depends, for the most part, upon the guidance of the state in the economical, political and military channels.

The guiding activity of the state is less direct and proximate relative to economics than relative to politics.

Having previously investigated how differently the states are qualified to exercise sea-power, there still remains to be considered the internal arrangement of the forces in the statical condition from which follows the greatest activity of sea-power in the dynamical condition.

These forces have two channels of activity, internal and external; the political activity must, therefore, so prepare both of these channels that the forces developed may have the greatest activity.

The internal political preparation will consist in so organizing the political forces as to produce the greatest impression and unification of the expansive activity, whilst the external preparation renders the latter favorable to the dynamics of sea-power. Internal politics applies itself, therefore, to the preparation of the national consciousness, external to international surroundings.

The principles which govern the preparation of the national consciousness are as follows:

1. The influence of the state upon external politics depends upon the unity and stability of the national consciousness, which almost always manifests itself in the permanence and stability of the government.

2. The tendency of the national consciousness to remain at rest depends primarily upon the ethnical characteristics previously discussed; its tendency to motion, upon the problems presented by the national and international politics.

3. The aims in the domain of external politics must be conceived as the results of the corresponding exertions of internal politics.

4. The unqualified preponderance of *one* of the aims of external politics over the others, as for instance, the maintainance of nationality and independence, retaliation, etc., simplifies the problem of internal and external preparation, though the solution may still remain difficult.

5. Should such a leading aim be lacking, thereby causing the national consciousness to become agitated and restless, the external and internal preparation would be difficult, and the guiding force of the state disturbed.

6. If the exertions in international channels are undefined but abundant, the political education of the national consciousness must endeavor to procure precedence for the exertions springing from the healthiest and strongest national forces.

7. Even if the political aim is attained by the national consciousness itself, yet it is only with difficulty that the latter comprehends the birth and decay of the germination, thus making political guidance essential.

8. The national consciousness tends to split up and multiply the various endeavours, whilst the political activity is constrained to permeate, compress, and restrict them to the smallest number.

9. The states which confound one political aim with another, under the pretext of prosecuting both simultaneously, only succeed in increasing the agitation of the national consciousness, whilst depriving it of the capacity to embrace an accurately defined aim and of becoming steadfast in it.

10. The stability of the national consciousness and the predominance of one aim of external politics can only be attained through a regulated, gradual development of the nationol forces; by this means the end to be attained is in harmony with the power resources of the state.

11. As the execution of the efforts in the international domain is always involved in more or less public and violent opposition, it is obligatory to develop all the forces which may enter into the struggle.

12. The development of the national forces must be so controlled as to combine on the theatre of war with the greatest activity.

13. The control of the national forces depends upon the degree of their relationship and upon their capacity of uniting, of their own accord, into a well defined system.

14. Should the national forces mutually repel each other, thus rendering the education to subordination difficult, the consequence is always a weakening of the state.

15. Race and religious differences, conflicts between state and church, induce the greatest and most dangerous weaknesses of the state.

16. Disturbances of the social and political balance which tend toward the dissolution of the state, threaten the greater weaknesses, the easier it is to cause a division of the national body for lack of sufficient patriotic strength.

17. Although the discord between land and sea interests produces a smaller and less important weakness, it may, nevertheless, if of sufficient duration, be irremediable, owing to its influence upon all branches of public life.

18. All clashings of the national forces exercise a mutually destructive influence, and where these clashings are both violent

and contemporaneous there is rather little prospect of crystallizing the national consciousness and clearly defining the aims of the state.

19. Lack of determination in the course of the state development is certainly an indication of a strong disturbance of the national consciousness.

20. An agitated national consciousness inclines to exaggeration and confusion, degenerates into unscrupulousness and makes the movements of the state nervous.

21. An agitated national consciousness is gradually curable, but with difficulty; states which realize their incapacity to cure it, create abundant revulsions through enterprises which almost always end in confusion and national misfortune.

22. A healthy national consciousness in a healthy national body is the best protection for a good and balanced internal political development.

After having examined and summed up the problems of internal politics, insofar as they relate to the preparation of the national consciousness, we must pass to the investigation of the methods which prepare and favorably determine the international surroundings for the external development of the state.

These investigations can not be limited solely to the theater of motion over sea, but must also be extended to the motion on land, as the problem is more or less amalgamated, in all states, with land interest, even though the state be a pure sea state.

The investigation of the laws governing the motion on land, independently of those over sea, is so broad and complicated a problem and such a vital question for the total motion of the state, that it would be an unpardonable offence to mangle it by forcing it within the limits of a study whose object is, in reality, the investigation of sea-power.

The principles which we might lay down would be too condensed and obscure without a suitable elucidation which we have not yet had an opportunity to develop. We therefore restrict ourselves, here, to simply citing a few propositions on the mutual relations between land and sea interests which, at the same time, also exercise an influence upon the external motion when the latter, as assumed, takes place with reference to the sea.

All European nations, including those which, owing to their island position, fancy they are free from the lasting influence of land interests, are exposed to it either because of the international equilibrium or because of their colonial possessions. Our propositions are not, therefore wholly applicable; they, however permit the passage from simple to complex problems, if the relations between land and sea interests do not exclude the predominance of sea-power in the motion of the nation.

No nation of the world presents such varied conditions of naval development as the Japanese. It might be regarded as the ideal of a state directed purely to a movement over sea, unless civil strife exists within the nation and discord between the land and sea interest.

The great simplicity of the present and future motion of Japan, permits this state to be taken as a model, to which the collected principles concerning the motion of a power directed exclusively toward the sea, may be applied with the greatest probablility.

In proportion as we recede from the pronounced predominance of the exertions at sea, the problem becomes amalgamated with subordinate aims, until finally the land interests predominate over the sea interests, and it becomes impossible to apply the principles governing the motion of a state exclusively directed toward the sea.

The study of naval efficiency necessitates the division of international politics into continental and sea politics. Reserving for ourselves the analysis, in due time, of the study of continental politics and its relation to maritime politics, which completes the study of the external dynamics of the state, we restrict ourselves here, to deducing the part of the study which is exclusively concerned with the motion of sea-power, of which the fundamental principles are as follows:

1. The motion of sea-power upon the international theater is composed of a continuous series of economical and military conflicts for the attainment of the aim of expansion.

2. The conflicts will continue to be the essence of the universal motion so long as dissimilarities of any kind exist, which are dissolved into dissimilarity of interests.

3. Conflicts may change their centers without changing their economical and military character; the business, therefore, of the political activity is to render the international situation favorable to the attainment of the aim of expansion.

4. Purely economical efforts are insufficient, even when strengthened by natural propagating forces, to support a lasting extension capacity, unless it coincides in one and the same direction with the military effort.

5. Exclusively military efforts, unaided by economical exertions, do not yield sufficiently firm foundations for the motion of sea-power.

6. A consistent adjustment between economical and military efforts is indispensable for the origin and growth of expansion over sea.

7. Economical insufficiency undermines military efficiency and military insufficiency prepares for, if it does not fully produce, economical ruin.

8. A clear division of the aims upon the international theater presents the best guarantee for a good employment of sea-power.

9. The aims upon the international theater are so much the easier to attain, the more they harmonize with the principles and fundamental interests ot the maritime situation.

10. The influence of the principles predominates in continental situations, that of the interests in maritime ones; consequently, the aims of expansion must stand in closer harmony with the interests than with the principles.

11. Maritime interests resolve themselves into systems of equilibrium; consequently, the aims must harmonize with the system which yields the greatest advantages from a mutual obligation of interests.

12. Since naval efficiency, as already indicated, is naturally impermanent, the interest in mutual obligations is also variable and transitory; consequently alliances can be relied upon to but a rather limited degree.

13. The nations which have sufficiently strong natural forces for the accomplishment of their efforts, will hold aloof, as far as their international situation permits, from mutual obligations, which always become irksome and limit the freedom of sea-power.

14. Advantageous as well as indispensable mutual obligations must be so chosen as to satisfy in the most advantageous manner the requirements of the aims to be attained at sea, since not all mutual obligations answer the purpose equally.

15. The gradation of maritime aims designates a logical distinction between the mutual obligations, which is more important than is usually admitted.

16. The modification of the aims progresses from small islands to great, then to coast lands and continental states, in such a manner, as to vary the reciprocal relations, which it is hoped to attain, between the mutual obligations and the aims derivable from them.

17. Small islands are almost exclusively important in a military, tactical or strategical relation; their possession excludes mutual obligations or only exceptionally permits such as assure their military superiority.

18. Large islands are economical owing to the activity of sea-power towards the aims to be attained; they exclude, therefore, those mutual obligations which do not assure the predominance of sea-power.

19. Coast lands are with difficulty protected by sea-power; they give rise, therefore, to more complicated problems than islands, and demand a greater guarantee of success than an unstable mutual obligation can bestow on them.

20. Continental states of even limited extent can not be protected by sea-power alone; they therefore constitute an aim, which, owing to the possibility of a mutual obligation of land and sea-power, can only be conceived by those nations whose predominating sea-power, in the usual attitude of the world, counterbalances the land power.

21. Since mutual obligations are based on the strength of the military power, it follows, that militarily weak nations have rather little hope of attaining their aims and none at all of long holding fast the attained aim.

22. The impermanency of naval efficiency precludes confidence in the endurance of mutual obligations and causes, by the unavoidable succession of wars, the exhaustion and spoliation of those nations which either can not or know not how, to create a great sea power.

After having investigated in broad and very incomplete strokes the problems embraced by the political activity in the preparation of the national surroundings, we pass to a consideration of the activity of the naval active forces.

C. THE ACTIVE FORCE.

The considerations analyzed above and the propositions derived from them, have fixed, if not completely established, the vast influence which the land as well as the sea power exercises upon the internal and external motion of nations.

Even if this view is instantly opposed by a pharisaical dogma, land, as well as sea power, nevertheless resists the centuries no less than the ponderous forces; we proceed, therefore, to regard them as the primary foundations of the international system. We are strengthened in our convictions by Mahan, who, in his works, and particularly in his predictions for the twentieth century, has repeatedly expressed the same views.

Assuming as the first principle of international dynamics, that just expressed, viz.: "That the active force is the vitality of the international system even if its essence and form incline it to warlike applications," it follows, that the problem of the active force, so far as it relates to its cooperation with political activity, consists in indicating to the latter, among the manifold aims upon the international domain, those which are attainable and in specifying what probability of success is to be expected in the accomplishment of the problem independently or under mutual obligations.

The determination of the order of the aims is, therefore, the special province of the military guidance, afterwards the external and internal situation is harmonized with the political government.

Since our problem is essentially concerned with sea-power, we exclude from consideration all aims relating purely to land-power and restrict ourselves to those alone, which exercise a direct influence upon the military employment of sea-power.

The fundamental characteristics which relate to this part of the study of naval efficiency seem to be as follows:

1. The employment of sea-power, excluding the mutual relations between land and sea-power, depends almost exclusively upon the extent to which the naval active forces are qualified for the consummation of the political problems.

2. The political and military activity should both cooperate in indicating the problems on the international domain and in fixing their gradual succession.

3. Political aims almost always transcend the limits derived from the strength of sea-power, because political and military leaders are not sufficiently in mutual accord.

4. An accurate comparison between political and military potentiality can not be established without a distinct graduation of the aim to be attained on the international domain.

5. For the elucidation of the scientific investigation, the problems may be distinguished as indispensable, relevant and supplementary, according to their weight in relation to the international situation.

6. To the indispensable problems belong the maintenance of the conditions essential to the life of the nation, when the latter can be threatened by an attack from the sea.

7. Isolated nations are vulnerable, in varied degrees, from the sea: be it with reference to their land domain, as Italy, or with reference to their communications, as England. In these cases the maintenance of the means of subsistence is an essential and unavoidable problem.

8. Whatever the sacrifice, the indispensable problems must

be accomplished with the national forces, independently of any mutual obligations whatsoever.

9. The nation which can not assure its own existence without the aid of allies is not to be regarded as a great sea-power and must restrict itself to a subordinate position in the second line of the group of powers.

10. The magnitude of the indispensable problem is determined by the magnitude of the attack by sea threatened by any power whatsoever.

11. Naval attacks are the more imminent the more they can be aided by direct land attack.

12. The indispensable problems may be accomplished more easily and with slighter sacrifice when it is a matter of defense against land attacks than when against naval communications.

13. A perceptibly smaller sea-power suffices, in a great measure, to prevent landing than is required to ward off an attack.

14. The mutual relative strengths of two sea-powers depend upon the preparation of the naval active forces and upon the theater of operations; under the assumption that the preparation is satisfactory in every respect, the strength of the defending fleet may be taken as from one half to two thirds that of the attacking fleet.

15. Naval communications can only be defended by a very superior fleet, which is adequate to every kind of naval warfare.

16. The nations which are threatened with exhaustion by the interruption of their naval communication must protect the latter by a fleet which, independently of any mutual international obligations, is twice as strong as that of the most imminent enemy.

17. Since both the preceding problems are the indispensable ones, whose non-accomplishment may greatly endanger the national existence, the valuable limits resulting for the strength of the particular fleet are one half and double the strength of the threatening fleet.

18. The relevant problems include all those arising from situations which, while they may very greatly injure the nation, do not call into question its existence.

19. To these belong all attacks upon the coast, commerce and colonies, which do not produce national exhaustion.

20. The magnitude of these problems, which do not involve the question of national existence, depens upon the ratio of the damage proceeding from a possible attack to the sacrifices which ought to be made to ward it off.

21. The order of the ratio varies from state to state, for the reason that the influence of the injury upon the national vitality and its capacity to protect itself against this influence, varies greatly among the different states.

22. The variation of the order also depends upon the variation in strength of the great sea powers, because an increase in such fleets changes the ratio and prevents the accomplishment of problems which would be possible in other circumstances.

23. The great increase in strength of the English fleet has changed this ratio for almost all European states, just as the numerical increase of the French fleet has altered the relative strength of France and Italy.

24. The relevant problems are therefore extremely complex and variable, their order in varying circumstance being established by corresponding changes in the military conditions.*

25. The supplementary problems include all expressions of the expansive capacity which can not be accomplished without the cooperation of the war power.

26. The propositions previously adduced on the relevant problems may be unhesitatingly applied to the supplementary problems, since the accomplishment of the latter requires a stronger sea-power than that required for the achievement of the relevant aims having the same order as those of the supplementary problems.

27. The domain of the relevant and supplementary problems has been more or less restricted, for all nations, by the remodelling of the English fleet. The English sea-power, on the other hand, is bound to the colonial possessions by the direct and indirect influences of the continental powers.

28. The question of the relevant and supplementary problems is thus resolved into one dealing with the mutual relative strengths of the land and sea-power, when it is complicated by alliances shared by England.

29. The order of the problems determines the portion which falls to the war power in the preparation of the means required for their accomplishment.

30. A good military preparation favors the assumption of a good political preparation, the latter is rarely ever followed by a good military preparation.

31. Political preparation is almost always more solicitous than military.

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* The relation between France and Italy was determined by us from an assumed fleet strength varying but little from that of the present time.

32. Insufficient military preparation, particularly of the naval active forces, is a characteristic phenomenon presented in history, and leads to the conclusion that harmony is lacking between the direction of politics and that of the active forces.

33. The discord between the two branches of service, which is diminished by the efficiency of the active forces, may arise from a faulty state organization as readily as from a clashing of interests.

34. Friction between domestic life and military power specially favors a weakening of the land power: consequently, a good military preparation is always difficult, even if the problems from which this fraction gains strength are well determined.

35. The predominance of commercial efforts is opposed to the development of the active forces, that of the war power, to the development of those forces which constitute the sources of its strength.

36. The conflict of authority springing from a discord between land and sea interests precludes not only a unified military, but also an efficient political preparation.

37. The systematic preparation of the land as of the sea power, is always slower, more troublesome and less complete than that of the materiel.

38. The preparation of the theater of operations is always less perfect and less adequate to the aim than the preparation of the active forces.

39. The preparation of the active forces according to intellectual and social standards is always less effective and satisfactory than according to their numerical strength.

40. The selection for the higher positions of command is almost always more difficult than for the lower, so that the subordinate commanders are, for the most part, more competent for their problems than their superiors.

These rather crude propositions are a concise abstract from the studies of war history, and permit the determination, in rough outlines, of the problems of the active force, which in conjunction with politics and social economy constitutes the impetus of the internal dynamics of sea-power.

(To be concluded.)

[Translated by 1st Lieut. FRANK E. HARRIS, 3d Artillery.]

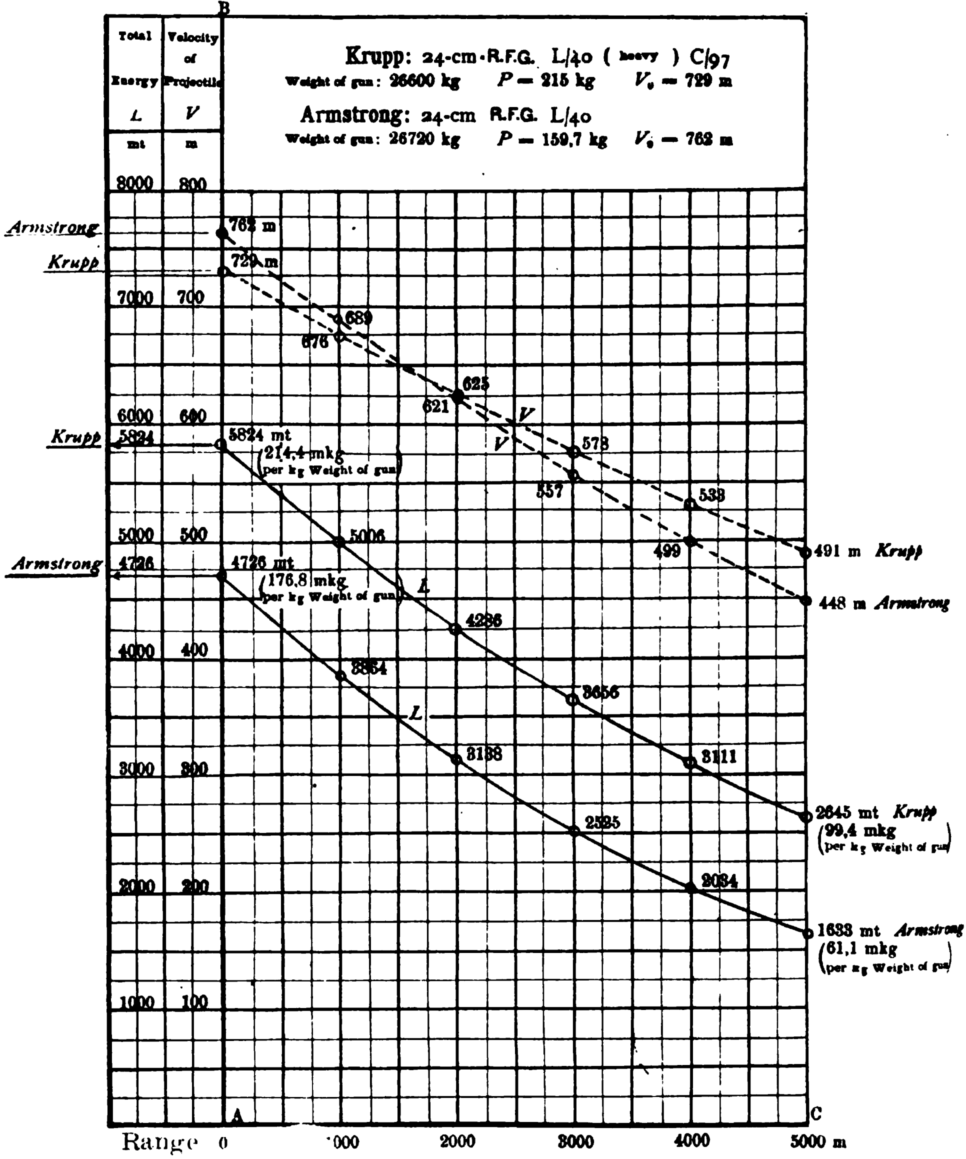
GRAPHICAL COMPARISON OF THE EFFICIENCY OF NAVAL GUNS.

The efficiency of modern ordnance is known to the expert from numeric tables giving velocities, energies, power of perforation of the projectiles, etc., at different ranges. Collections of numeric data, however, are not to everybody's taste. A clear understanding is obtained much easier, and in a more direct way, by the graphical method, which is nowadays used to show the movements or changes in all important relations of life and labor. The annexed diagrams have been designed to convey to the reader at a glance a correct opinion of the comparative value of certain naval guns. They show the energies of the projectile when leaving the muzzle of the gun, and at various fighting distances. As to our knowledge the well known German author, Captain Castner, has been the first to apply the graphical method to show the ballistic properties of guns, we have thought it of special interest to our readers to reprint the very instructive article from the German paper Prometheus.

It is not always possible in constructing a gun, says Captain Castner, to reach the greatest energy of the projectile obtainable within the limits of its caliber. The purpose of the gun, the special use for which it is designed, may necessitate a compromise, sometimes with a considerable reduction of its energy. High angle and vertical fire, as from howitzers and mortars, for instance, can not be combined with maximum energies. Rapid-fire field guns, although their trajectory is flattened, are less efficient, and convey a much smaller energy to their projectiles than rapid fire naval guns of equal caliber, as a field gun has to be light to be moved from place to place, while a naval gun remains stationary. The English naval 7.6-centimeter (3-inch) gun L/40, for example, which in the South African war was taken ashore, put on Captain Scott's improvised wheeled gun carriage and used before Ladysmith and at other places, throws a shell weighing 5.7 kilogrammes with a muzzle velocity of 670 meters and an energy of 131 meter-tons; while English field guns, model of 1894–95, of 7.6-centimeter (3-inch) caliber, which also were in use against the Boers, convey to their 6.3-kilogramme shell only 471 meters initial velocity, or 71.8 meter-tons initial energy.

As will be seen from the above, with naval guns the leading

Velocities and Energies of Projectiles up to 5000m from the muzzle **Plate I**

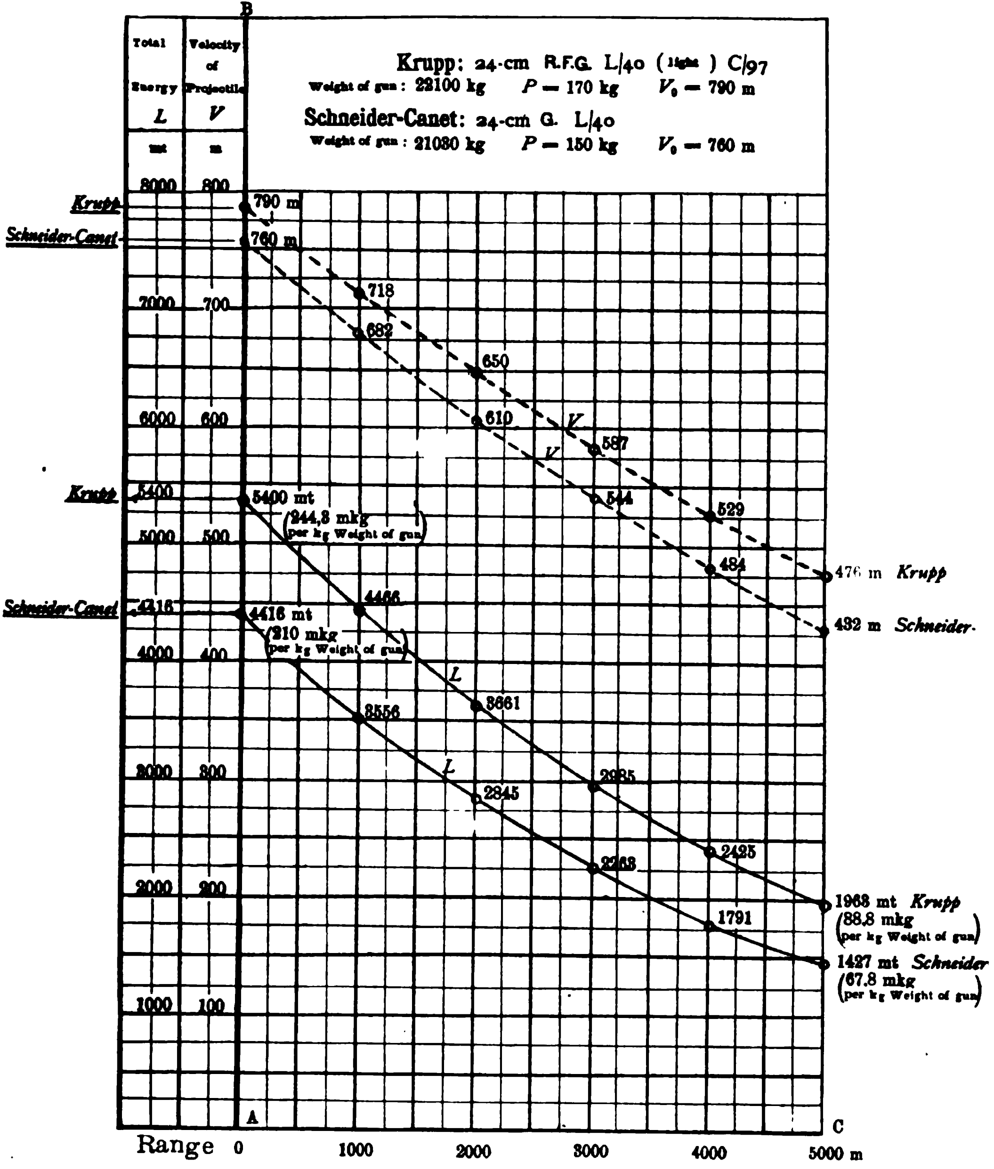


idea is to reach the maximum of hitting energy which their caliber will allow within a reasonable limit of the gun's length, for having to attack ship's armor, they require great perforating power.

The annexed diagrams illustrate what has been accomplished

Velocities and Energies of Projectiles up to 5000m from the muzzle

Plate II



in this regard, and will help the reader to form a definite opinion about the naval guns of different sytems.

On Plates I. and II. the upper dotted lines refer to the velocities of projectiles. Issueing from those points of the ordinate of velocity A B (see Plate I.) which answer to the muzzle velocities given in the headings,* these curves, as they descend from left to right demonstrate the gradual loss in velocity up to a range of 5,000 meters.

The better the projectile maintains its velocity, the less the curve deviates from the horizontal.

With guns of equal caliber, then, one might be led to think that a projectile leaving the muzzle at a higher velocity would lose less of it during its flight than one of smaller muzzle velocity. This, however, is not always so, as shown for instance on Plate I. Here the dotted curve of the velocities of a projectile leaving the muzzle with 729 meters deviates much less from the horizontal than the dotted curve of a projectile of 762 meters muzzle velocity. At the range of 5,000 meters the former still retains 491 meters, the latter only 448 meters. And why? Because there is a difference in weight of the two projectiles, that of the first dotted curve being 55.3 kilogrammes heavier than the other. The heavier projectile is less influenced by the resistance of air, and therefore keeps its velocity better than the lighter one.

The lower, full-drawn curves mark the energies of projectiles. They issue from a point of the first ordinate corresponding to the energy with which the projectile leaves the muzzle.

Energy is a function of both the velocity of the projectile and its weight. The amount of energy is the essential proof of the efficiency of a gun. Data of high velocities, unaccompanied by data of weights of projectiles or energies of projectiles, are insufficient to form a judgment of the gun, and apt to mislead and bluff the reader, the more so as they have the appearance of being scientific. The curves on Plate I. demonstrate this by a very good example: The initial velocity of Armstrong's 24-centimeter gun L 40 is by 33 meters greater than that of Krupp's gun of the same caliber and length (762 against 729 meters), but its muzzle energy is 1,098 meter-tons smaller (4,726 against 5,824 meter-tons), and at a range of 5,000 meters is still 1,012 meter-tons smaller. In other words, Krupp's gun conveys to its projectile an average of 1,000 meter-tons more energy; its efficiency is from 20 to 25 per cent. higher.

A similar comparison with the Schneider-Canet gun would show that though it has a greater velocity than the Krupp gun, its fighting power, however, is far less.

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* For the non-expert reader we add a few explanations Initial or muzzle velocity is expressed by so many meter-seconds, or foot-seconds, meaning that the projectile after leaving the bore would travel so many meters or feet during the first second. This velocity is given in the headings of the plates and according to international usage is called V_0; V means velocity, L means energy of projectile, P means weight of projectile, L 40 means 40 calibers length, C 97 means construction (or model) of 1897, R. F. G. means rapid-fire gun.

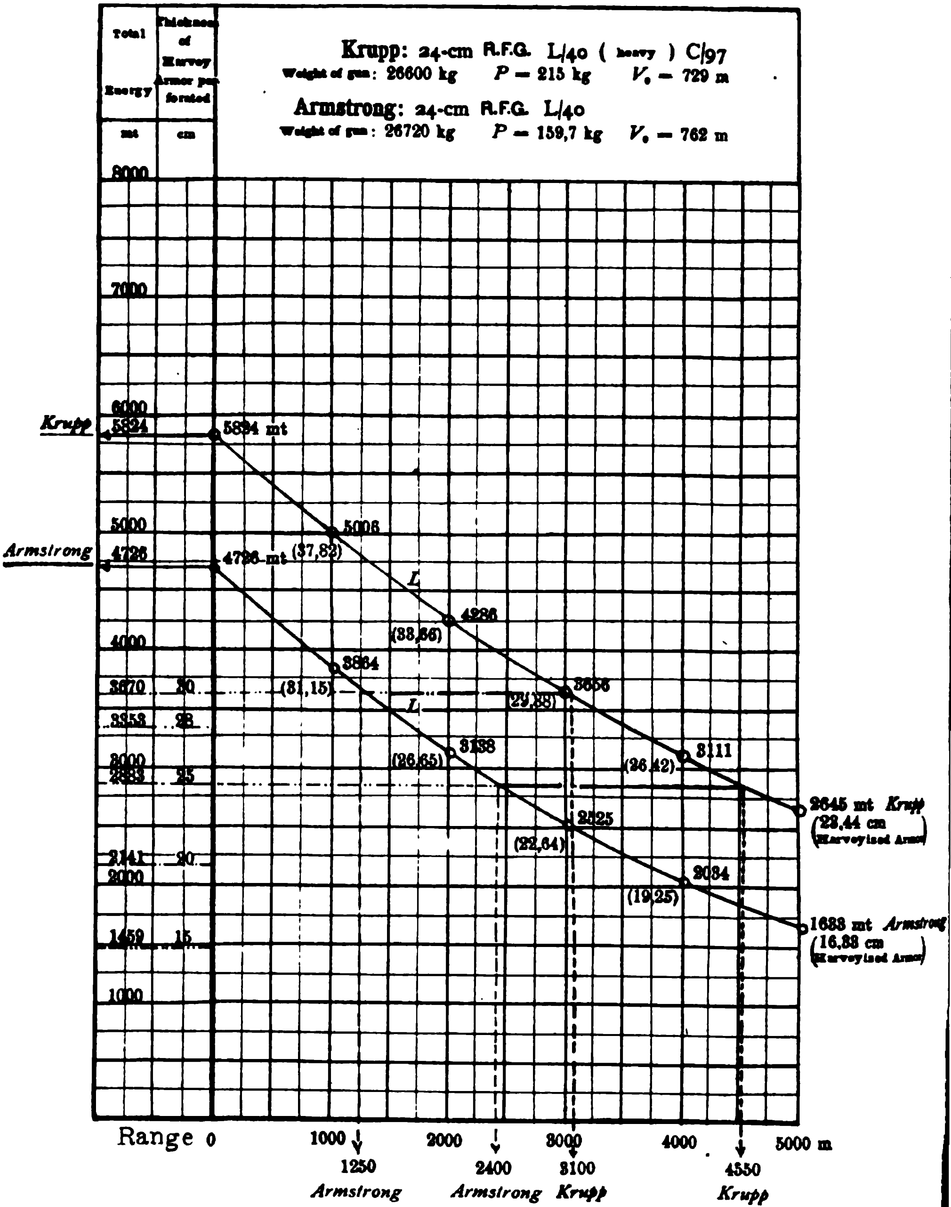
It has been said before that the leading idea in constructing a naval gun ought to be to give it the greatest possible power of perforation. But that does not imply that the weight of the gun is of no consequence. Everything else being equal, the gun of smaller weight is always preferable, because it is more easily handled, and it uses up less of the carrying capacity of the ship, which is always to be treated with the utmost economy. A light gun of the same efficiency as a heavier one speaks well for its quality, both as to material and to construction.

This quality of the gun is usually expressed by stating the amount of energy of the projectile for every kilogramme (or pound) of the weight of the gun. On Plates I. and II. these data are added to those of the total energies at the ranges of 0 and 5,000 meters. It is remarkable how much the German gun's construction is superior in this respect to the English one, the more so as the English guns are wire guns, the wire construction being adopted with the pronounced purpose of obtaining a better relation between energy of projectile and weight of gun than had been possible with the English hooped guns made of Martin-Siemens steel.

The efficiency of guns is generally expressed in meter-tons or foot-tons. Familiar as it is to experts, to others this way of measuring appears rather academical. To them it seems simpler, and of a more direct practical interest, to learn how thick an armor plate may be which the projectile will be just able to perforate, striking it normally, at certain ranges. Comparing the power of perforation of guns furnishes direct practical knowledge. For this reason two more plates, Ia and IIa, have been added to those showing the velocities and energies. They repeat the energy curves the same as on I. and II., but the numbers which give the energies in meter-tons are supplemented by other bracketed numbers, expressing in centimeters what thicknesses of harveyized armor can be perforated when hit normally with these energies. Such thicknesses of armor have been calculated only for the principal fighting ranges, viz., for 1,000 to 5,000 meters. The plates also contain graphical information, showing up to what range the perforating power of the guns in comparison is sufficient against armor of two different thicknesses. On Plate Ia, for example, it is shown that Krupp's 24-centimeter (9½-inch) rapid-fire gun perforates harveyized armor 30 centimeters thick up to 3,100 meters range, while Armstrong's gun of

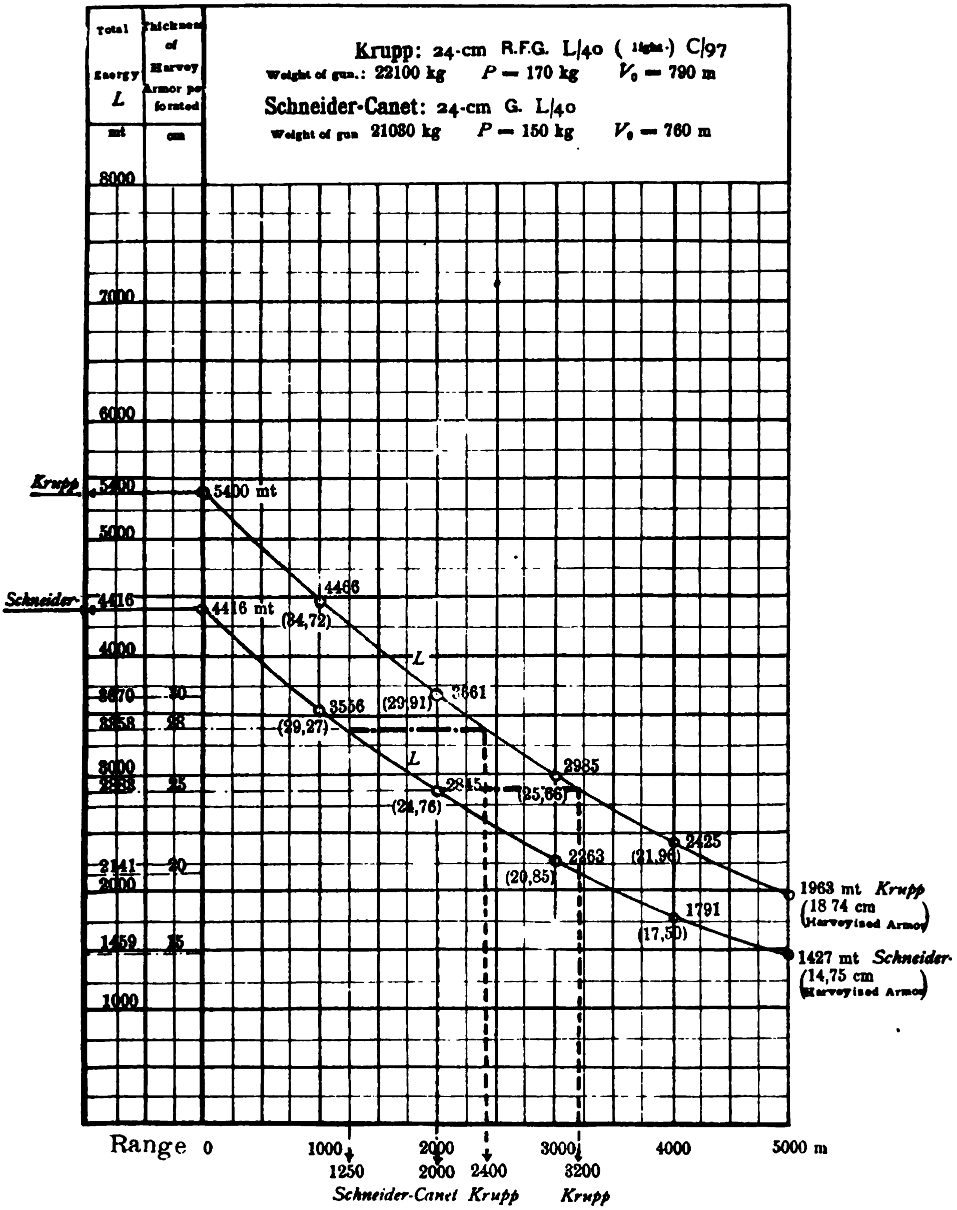
Power of Perforation of Harveyized Armor

Plate Ia



the same caliber, in spite of its greater muzzle velocity, can do this only up to 1,250 meters. Harveyized armor 25 centimeters thick is perforated by Armstrong's gun up to 2,400 meters, by Schneider-Canet's 24 centimeter L/40 gun not even beyond 2,000

Power of Perforation of Harveyized Armor **Plate IIa**



meters range (see Plate IIa), while the energy of the Krupp gun does it up to 4,500 meters. The superior power of the German construction is also clearly demonstrated in Plate IIa. And still

Krupp's guns C/99 have even higher power of perforation than those of C/97, to which the graphic plates refer, and their superiority over English and French guns is even greater.

It is evident of what importance this superiority and perforating power must be in the first stages of a naval engagement, when fire is opened at the longer ranges.*

Captain Castner closes his article with the following words, which seen in the light of recent political events seem of particular interest: "Considering the pending increase of the German navy, these considerations are of the greatest interest. Germany's development is a strong motive to raise her sea power as much as she can possibly afford. One of the most important factors, the construction and manufacture of ordnance, is undoubtedly progressing in the right direction."

Postscriptum.—It will be noticed that the diagrams refer to Krupp's guns of C/97 only, and not to his more recent designs, which are called C/99. Since the original of this article appeared in the German review Prometheus, new data of some foreign guns, especially of Schneider-Canet's, have been published in the English Brassey's Annual for 1900. If these quite new designs are put into account, it is just to compare them with Krupp's C/99, the data of which also appeared in Brassey's Annual. It will be found, then, that the relative value of the two systems has practically remained the same as demonstrated in the above article.

—*Scientific American Supplement*, December 1, 1900.

Scientific American of December 1st prints an extract of an article by the well known military author Captain Castner in the German periodical *Prometheus* under the above heading. The article is illustrated by diagrams comparing the Krupp 24 cm. (9½-inch) L. 40 Rapid Fire Guns Mod. 97 with Armstrong's and Schneider-Canet's guns of the same caliber and length, as to their energy and power of perforation up to a range of 5.000 m. The German original contains two more plates for comparison between Krupp's 15 cm. (6-inch) L. 45 (heavy) Rapid Fire Gun Mod. 97 with Schneider-Canet's gun of the same caliber and length, which we reproduce here (Plates III and IIIa).

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* Armor of all kinds and different grades of resistance is met with on the different older iron and steel-clad ships of all fleets. In order to enable the reader to obtain the necessary data for other than harveyized armor, the following comparative resistances are stated here: The relation between the resistance of equal thicknesses of wrought iron, compound, harveyized, and Krupp armor, in round numbers, is as 1 to 1.2 to 2 to 3, meaning that Krupp's armor furnishes three times as much resistance as wrought iron.

Velocities and Energies of Projectiles up to 5000 m from the muzzle

Plate III

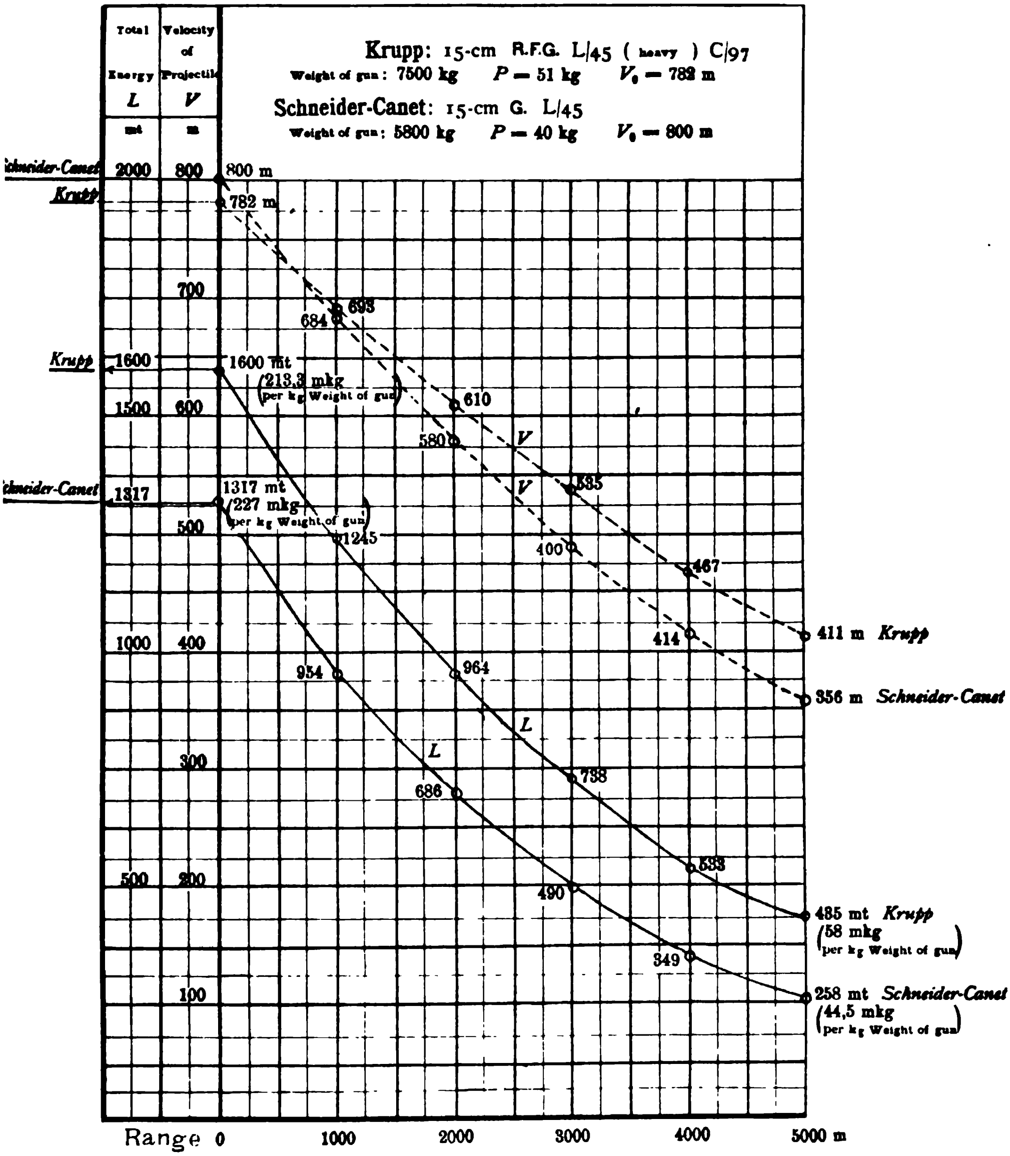
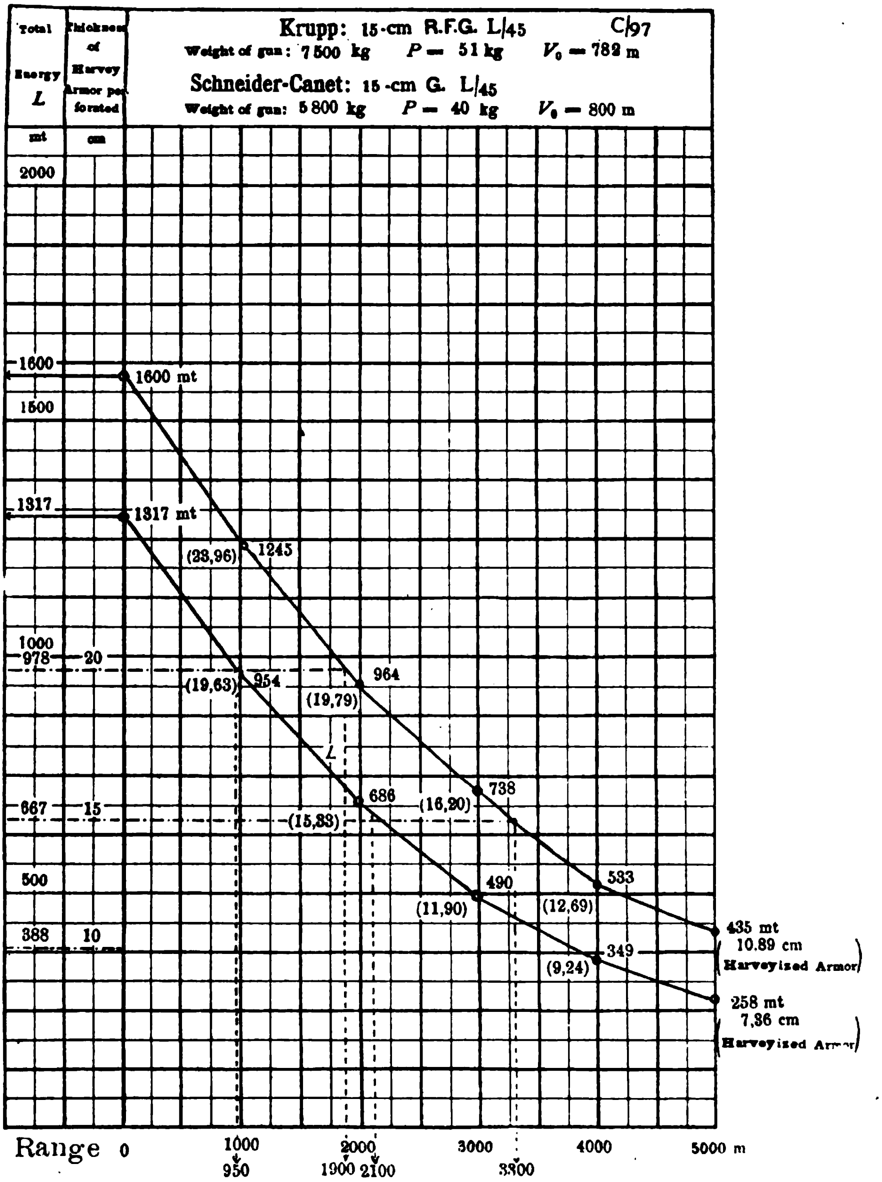


Plate III shows that, although the French gun has a higher initial velocity than the Krupp gun (800 m. against 782), its fighting power is much inferior, its muzzle energy being much smaller (1,317 metertons against 1,600). Its lighter projectile

Power of Perforation of Harveyized Armor **Plate IIIa**



(40 kg. against 51) loses its velocity much quicker, so that even at 1,000 m. range it is below that of the Krupp projectile (684 m. against 693) and at 5,000 m. range the velocities are 356 m. against 411, the striking energies 258 metertons against 435.

The energy per unit of weight of the gun is at the muzzle slightly higher with Schneider-Canet's gun (227 kg. meters against 213.3) but is very much in favor of the Krupp gun at striking ranges. At 5,000 m. ranges: Krupp 58 m. kg., Schneider-Canet 44.5 m. kg.)

Plate IIIa shows the thickness of harveyized armor-plates that can be perforated by the two guns at the various ranges, and demonstrates that 20 cm. of harveyized armor are perforated by the Krupp gun up to 1,900 m. range, by Schneider-Canet's only up to 950, and 15 cm. of the same armor by Krupp's gun up to 3,300, by Schneider Canet's up to 2,100 m. range.

In a postscriptum to the article in *Scientific American* attention is drawn to the fact that both Krupp's guns as well as Schneider-Canet's have recently produced more powerful guns of the same calibers but of greater length, but that their comparative value has remained about the same.

To prove this we can give our readers some authentic data:

Brassey's Naval Annual for 1900 gives the following data for a Schneider-Canet 24 cm. L. 45 Gun (A):

A. Weight of gun 23,1000 kg., weight of projectile 150 kg.
Muzzle velocity = 850 m., which furnishes
Muzzle energy = 5,555 tm.
Muzzle energy per kg. of gun's weight = 240 m. kg.

The *Extrait du volume annexe du catalogue officiel* of the Paris Exposition gives the following for a Schneider-Canet Gun of the same caliber and length:

B. Weight of gun 23,000 kg., weight of projectile 202 kg.
Muzzle velocity = 750 m., which furnishes
Muzzle energy = 5,797 tm.
Muzzle energy per kg. of gun's weight = 252 m. kg.

Krupp's 24 cm. L. 45 (light) Rapid Fire Gun Mod. 99 has

C. Weight of gun 25,500 kg., weight of projectile 215 kg.
D. and 170 kg.

Muzzle velocities 850 m.
and 922 m.

Muzzle energy 7,376 tm.
and 7,373 tm.

Muzzle energy per kg. of gun's weight = 289 m. kg.

For fighting distances this will result in the following comparative energies and power of perforation in harveyized armor:

At Ranges of m.	Energy.				Perforation in Harvey armor.			
	Schneider-Canet Guns.		Krupp's R. F. Gun.		Schneider-Canet Guns.		Krupp's R. F. Gun.	
			Heavy projectile.	Light projectile.			Heavy projectile.	Light projectile.
	A.	B.	C.	D.	A.	B.	C.	D.
	tm.	tm.	tm.	tm.	cm.	cm.	cm.	cm.
0	5555	5797	7378	7373	—	—	—	—
1000	4523	4935	6369	6178	35.05	37.42	45.30	44.28
2000	3639	4195	5498	5142	29.77	35.08	40.58	38.59
3000	2916	3539	4706	4262	25.22	29.16	36.10	33.52
4000	2317	2983	4028	3508	21.22	25.06	32.13	29.00
5000	1838	2525	3448	2868	17.84	22.57	28.54	24.90

35 cm. harveyized armor will be perforated by
Schneider-Canet Gun A, up to 1400 m range.
Schneider-Canet Gun B, up to 2000 m "
Krupp R. F. Gun, heavy projectile, 3800 m range.
Krupp R. F. Gun, light projectile, 3100 m "

30 cm. harveyized armor will be perforated by
Schneider-Canet Gun A, up to 1950 m range.
Schneider-Canet Gun B, up to 2700 m "
Krupp R. F. Gun, heavy projectile, 4600 m "
Krupp R. F. Gun, light projectile, 3800 m "

25 cm. harveyized armor will be perforated by
Schneider Canet Gun A, up to 3050 m range.
Schneider-Canet Gun B, up to 4150 m "
Krupp R. F. Gun, heavy proj., over 5000 m "
Krupp R. F. Gun, light projectile, 4950 m "

A similar comparison can be made between the latest European 6-inch naval guns:

Brassey's *Naval Annual* for 1900 shows the following for Schneider-Canet's 15 cm. (6-inch) L. 50 Gun:

Weight of gun: 6300 kg.; weight of projectile: 40 kg.
Muzzle velocity: 835 m.
Muzzle energy: 1423 tm.; per kg. of weight of gun: 224 m. kg.

Krupp's Rapid Fire Gun of the same caliber and length, Mod. 99, has

Weight of gun: 6900 kg.; weight of projectile: 41 kg.
Muzzle velocity: 958 m.
Muzzle energy: 1920 tm.; per kg. of weight of gun: 278 m. kg.

These data result in the following energies, and perforation in harveyized armor at fighting ranges.

At Ranges of	Energy.		Perforation.	
	Schneider-Canet's Gun. 15 cm. L/50	Krupp's R. F. Gun. 15 cm. L/50	Schneider-Canet's Gun. 15 cm. L/50	Krupp's R. F. Gun. 15 cm. L/50
m.	tm.	tm.	cm.	cm.
0	1423	1920	—	—
1000	1046	1452	21.03	26.89
2000	756	1069	16.50	21.38
3000	539	778	12.79	16.85
4000	375	559	8.75	13.15
5000	279	403	7.81	10.29

20 cm. harveyized armor is perforated by
    Schneider-Canet's 15 cm. L. 50 up to 1250 m range.
    Krupp's 15 cm. L.50 R.F.G., Mod. 99, up to 2250 m "
15 cm. harveyized armor is perforated by
    Schneider-Canet's Gun up to 2350 m range.
    Krupp's Rapid Fire Gun, 3500 m "
10 cm. harveyized armor is perforated by
    Schneider-Canet's Gun up to 3950 m "
    Krupp's Rapid Fire Gun, above 5000 m "

Captain A. E. Piorkowski,
Imperial German Army.

◆

THE DEVELOPMENT OF THE KRUPP FIELD ATTILLERY MATERIAL.*

(Translated from the German by M. WILLIAMS, and arranged for publication in the office of the Chief of Ordnance.)

(Continued.)

II.

Meanwhile the hydraulic brake between spade and trail, as well as the above-mentioned elastic revolving spade, have been dropped and two new forms of elastic method of control, dependent upon spring power have been adopted, worked out and tested with numerous variations. In one model (I) the point of contact is farther forward, in the other (II) it is farther back.

Construction I starts as already mentioned, from the axle spade, gives the latter a more favorable shape and direction and transforms the rigid into a spring impact. This is the brake described later as the "long spring spade." (Imperial German Patent 84,376 of August 28, 1894; see figs. 8*a*, 8*b*, 8*c*.)†

The construction consists in the application of a brake rod, *A*, to the carriage, the forward part of which is connected by a link-bolt, *B*, with the carriage-flasks *C* or the carriage axle *D*, while the rear part *E*, on which the forward part can slide back under tension of the springs, is in fixed connection with the spade *F*. By the shock of firing this spade is driven into the earth, causing the forward part of the rod to recoil with the carriage against the firmly set rear part. In consequence the rods telescope, the springs are compressed and take up part of the backward momentum, which compression is utilized to again run the carriage forward. The simple contrivance *G* provides that the carriage flask shall not detach themselves too far from the spade during firing, and that the latter shall not hang down when the gun is limbered up. Also the whole rod can be shortened without straining the spring. This construction has also been made so that the rod with the spring on it or in it slides in a rest attached to the forward part of the carriage, while the spring is restrained by this rest. On firing, the rod is pushed forward through the rest, and the spring which is held fast in front is compressed.

Construction II, with the working point of the means of control directly on the trail (Imperial German Patent 87,996 of

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* Reprinted by permission of the Chief of Ordnance, U. S. Army, who also very kindly loaned us most of the plates.—ED.

† See preceding number of *Journal*.

August 28, 1894, and 88,540 of July 23, 1895), resembles somewhat the before-mentioned revolving elastic spade, and the older spade model of the year 1872. It differs from the first (Imperial German Patent 65,948 of March 19, 1892) in that the spade does not yield at the moment of greatest resistance, but acts like a rigid spade, and furthermore in that the power of the compressed spring is used to return the gun into position. Constructions I and II are typical of the development of Krupp field carriages, and it is worth noting how they tend to approach one another as the sweep of the spade of II is gradually increased. The simplest model of Construction II was used up to 1895 on all Krupp field carriages, excepting on those which were made only for experimental purposes; it was described as a tongue spade, either with Belleville springs, the usual way, or with rubber buffers, according to Fig. 9.

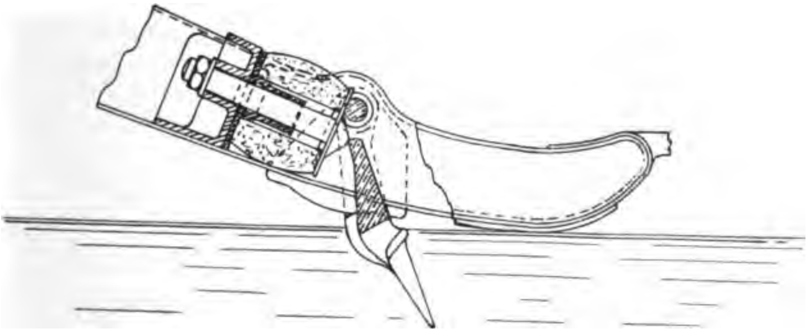


Fig. 9.

The chief characteristics of the tongue is that a long path is allowed for it, or, more correctly, for the carriage, whereas the compression of the elestic medium is slight. The remarkable favorable working of the spade in this respect is shown in the progressive figs. 10*a* and 10*b*.

Whereas before firing the spade is pointed obliquely backward, during the recoil the direction changes more into a right angle with the ground, which position is only slightly passed when the recoil is entirely over. Even on hard, for instance frozen ground, which it is impossible to penetrate, the spade still contributes to reduce the recoil. In regard to elastic intermediaries, only rubber buffers of the best qualities, very difficult to obtain, can be used, because any other kind, under the influence of time and weather, break and tear and lose their elasticity. As long as the rubber buffer is new it works very well. Good cup springs are easier to obtain, and furthermore the breaking of a few elements which are easily replaced does not affect the working of the spade.

Considered as part of the carriage, preference must be given to the tongue-spade, over the long spring spade, which weighs about 90 kg. (200 pounds), because the former is simpler, lighter, less liable to injury, and less cumbersome for transportation than the latter.

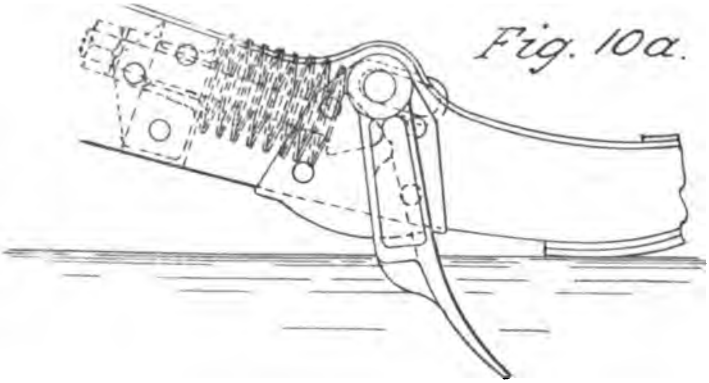


Fig. 10a.

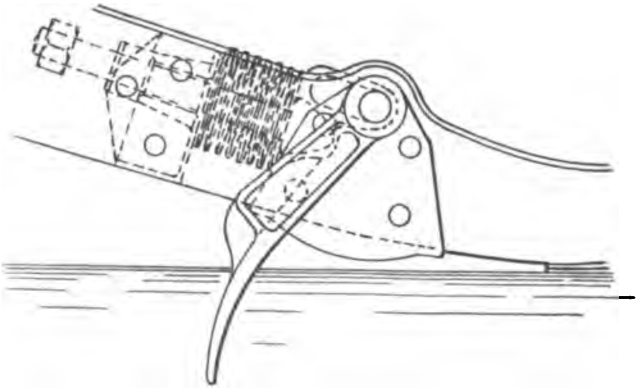


Fig. 10b.

Two further models of tongue spades are shown in figs. 11*a*, 11*b* and 12, one with a clock spring, the other with a spiral spring.

In the case of guns of not very great ballistic effectiveness, especially without too heavy weight of projectile and with consequently moderate velocity of recoil, the simpler form, even with short spade path, is sufficient. It is different with great momentum of recoil. It was necessary in this case to increase the spade path, and it was attempted at the same time to give the spring power a more advantageous point of support by attaching one end of it under the carriage flask, the other end being secured to the lever, which formed the arm of the spade. This brought about the two lever spades shown in figs. 13 and 14, and on Plate VI, one a swinging, the other a sliding model, according to whether the spring power has a double guide or not.

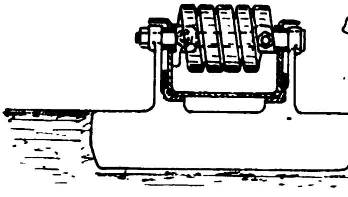


Fig. 11a.

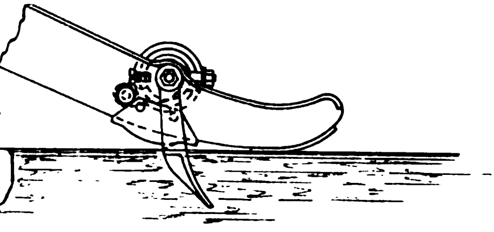


Fig. 11b.

Another attempt was made to use hydraulic pressure with the swinging-lever spade, in this case utilizing the spring power only as a means of return, as shown in fig. 15 and on Plate VI.

These constructions have the drawback that difficulties are encountered in detaching the spade, which detachment is a necessity, or might be desirable for firing on rocky or frozen ground.

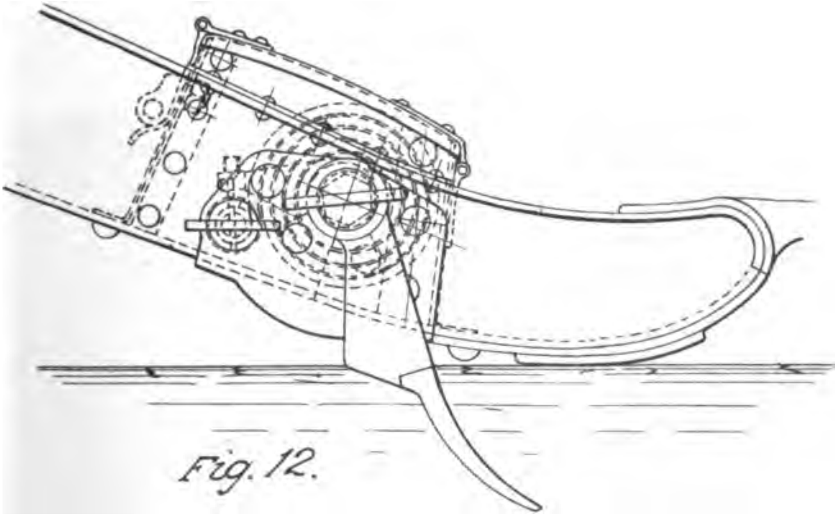


Fig. 12.

As shown by the sketches, none of the spade models were detachable, therefore care had to be used not to make their dimensions sufficient to impede transportation of the carriage when limbered up. Only after reconstructing the models were the elastic spades made detachable. This gave rise to the folding spade, which was simply turned up over the carriage trail (Plate IV). In a later model the spade was secured by a hinge flat to the underside of the carriage flasks, as shown in fig. 16 and on Plate V.

The possibility of detaching the spade allowed greater latitude in the demensions thereof, as when in a disengaged position it can no longer catch in the ground during transportation.

The tongue spade described above, with short throw, combined with a short carriage, well adapted for transportation, answers well for the moderate ballistic effectiveness, sufficient in the opinion of Krupp's factory, for field service.

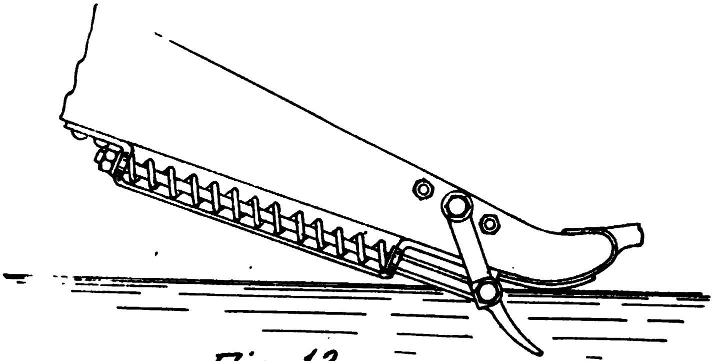


Fig. 13.

If the ballistic effectiveness is considerably increased, as attempted in certain quarters, the gun becomes unsteady during firing, the jump is troublesome, and the deflection from the line of sight, especially on unfavorable ground, becomes frequent and considerable.

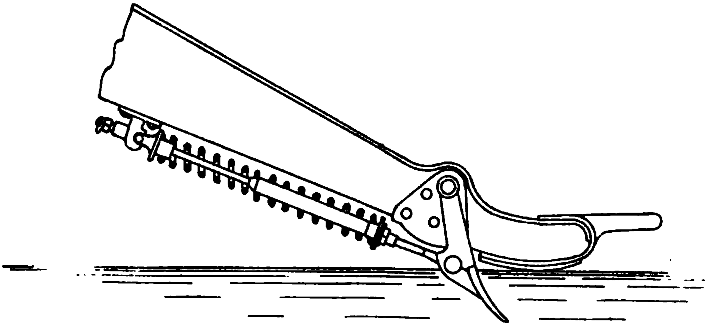
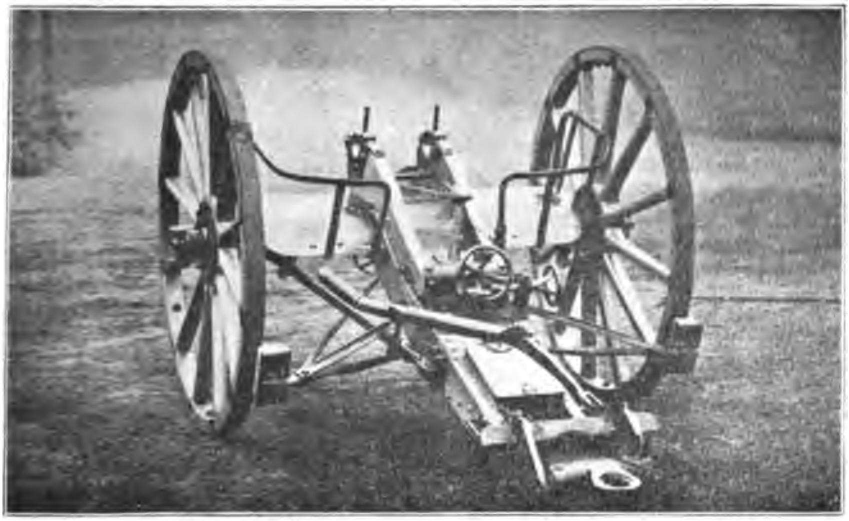


Fig. 14.

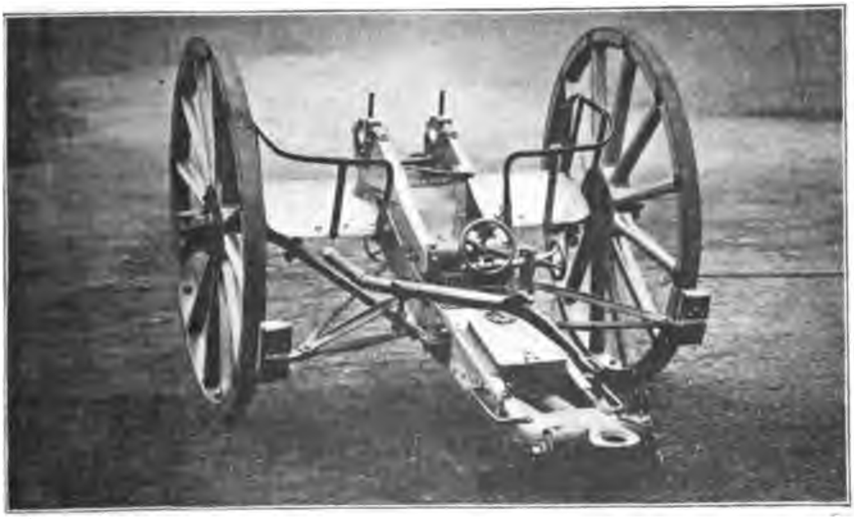
Three rules serve to eliminate these evils, in connection with reducing the height of the gun above ground, which, however, can not now be carried any farther, viz: (1) The increase of the

PLATE IV.

Rapid-fire field carriage with elastic folding spade.



A.—Spade folded up.



B.—Spade in firing position.

temporary recoil; (2) lengthening of carriage; (3) increase of weight of the system.

In regard to the carriage, rule 3 becomes imperative through the application of rules 1 and 2.

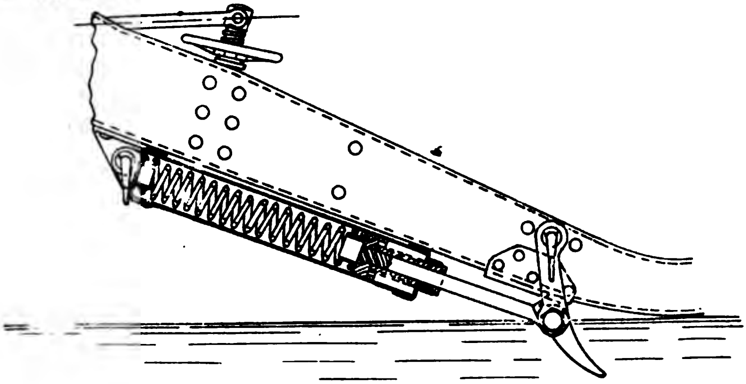


Fig. 15.

The most effectual increase of weight is that of the gun, but the maximum admissible weight of the piece leaves only a narrow margin for this.

To increase the temporary recoil, the axis of the spade, which was located hitherto in the trail, must be moved higher up, which lengthens the lever arm. (See fig. 17 and Plates V and VI.)

With this arrangement and the use of hydraulic pressure it becomes possible on hard, level ground to make the recoil and subsequent running forward of the gun work more smoothly than in previous constructions, because the hydraulic brake makes the checking of the recoil more even and also moderates the return. On the other hand, tests show the already recognized important fact that the spring on unfavorable ground must be strong and so long that it is in itself sufficient to overcome the recoil. With unfavorable conditions of ground, such as a pitch to the rear, or soft earth, cases occurring frequently in war, not only the utter uselessness, but also the harmful effect of hadraulic brakes

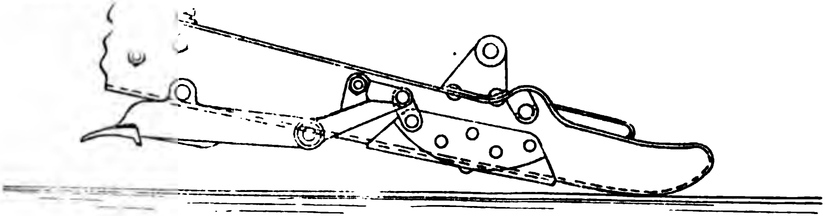
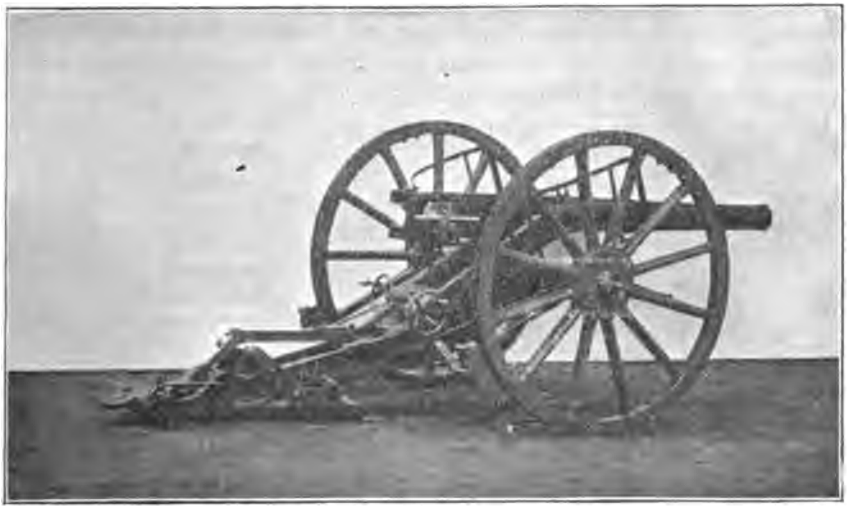


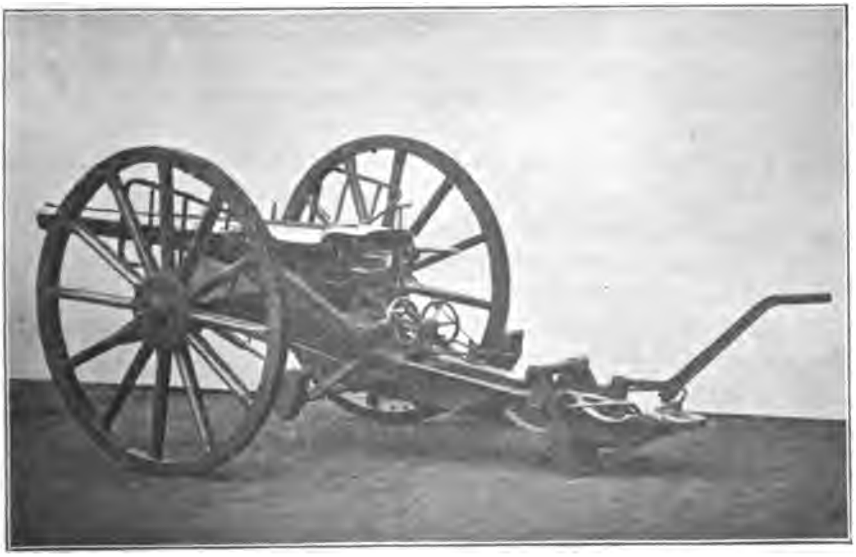
Fig. 16.

PLATE V.

2.95-inch rapid-fire field gun on field carriage, with adjustable elastic spade. Fulcrum of spade above trail.



A.—Spade out of action.



B.—Spade in action.

is apparent. It becomes necessary in the absence of the latter, to oppose a graduated resistance to the over-violent return, something fully attained by a simple contrivance. (Imperial German Patent 98,219 of April 13, 1897.) Such a device is applied to the gun shown in Plate V, and fig. 17 gives a sketch of it; rod *A*, carrying the spring cups, with one end secured to the spade *S*, grows thinner towards the other end, and is carried between two bronze clamps, *B*, the divergence of which can be altered by screw *C*. To increase the friction, the rod is split and holds in this slit a friction plate, which is held immovably between the clamps.

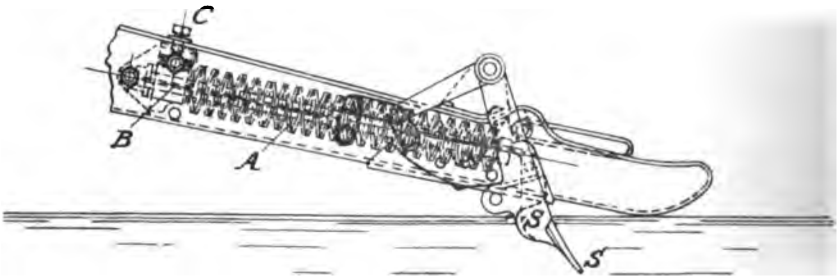
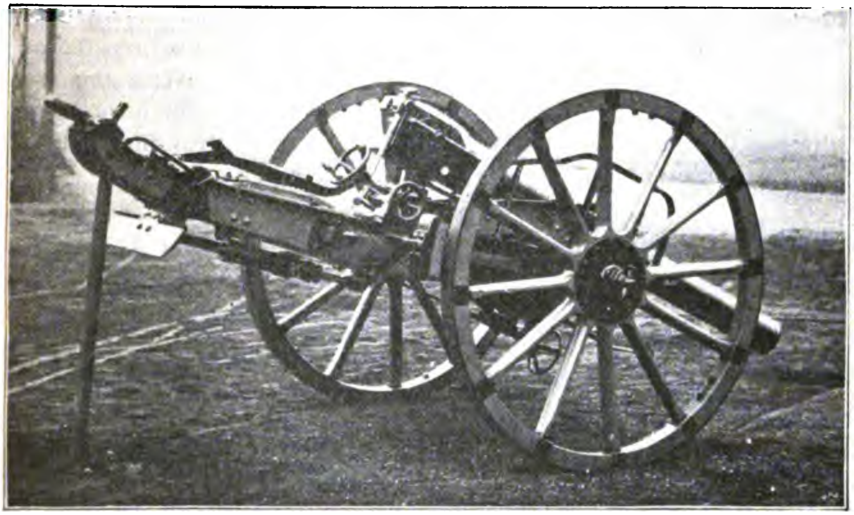


Fig. 17.

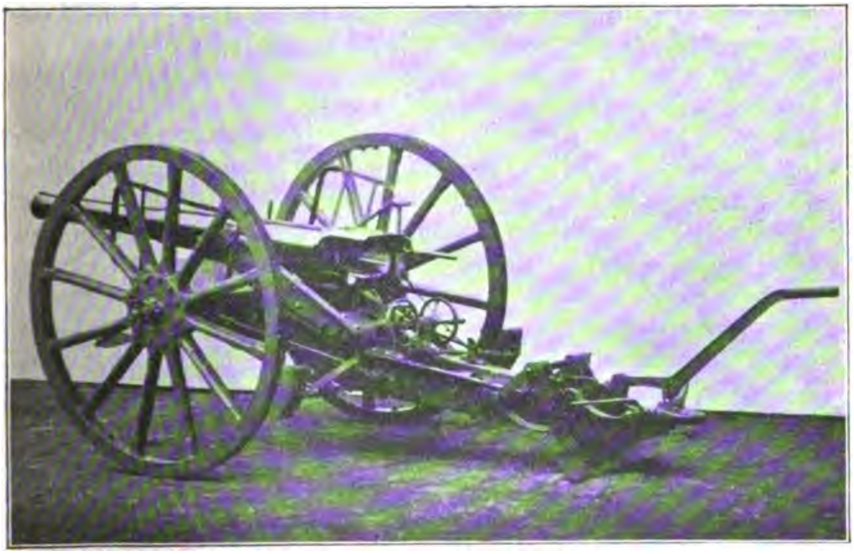
Owing to the conical form of the rod *A* and the degree of adjustment of the clamps *B* obtained by tests, a perfectly easy action is reached—that is, the recoil and return of the gun are quite smooth. The possibility of regulating the latter goes further, inasmuch as by tightening or loosening the screw *C* the control of the return resistance can be reduced or increased to suit the exigencies of the ground. It must be observed that not only the weight and ballistic effectiveness of the gun but also the nature of the ground affects the working of the brake very considerably, so that a construction which would be right under all conditions, is not obtainable. Admitting, as a rule, that in war the batteries are stationed behind the crest of a hill, on a gentle slope say of 5 degrees, if the brake is set accordingly, then on level ground there would be superfluous energy, whereas on a steeper declivity the power would be insufficient. The conditions were so equalized with the tongue spade with short throw and the short trail that recoil and return relieved each other under the conditions arising most frequently in the field. With a spade of long throw on level ground, or on a favorable slope, a moderation of the return coil is desirable, and this is obtained with the last-mentioned spring spade brake with device for adjustment.

PLATE VI.

2.95-inch rapid-fire field-gun carriage with elastic spade.



A.—Short lever spade, with oscillating hydraulic brake beneath the trail.



B.--Extended folding-lever spade, with hydraulic brake between the flasks.

With such a carriage, firing was accomplished on a slope of 13 degrees forward inclination. The brake and carriage proved equal to these extraordinary demands. To prevent the running down hill of the gun on the counter recoil, the road brake had to be applied before firing. It was found to be unnecessary to release the brake after each round fired ; on the contrary, it was possible to continue rapid fire with locked brake. With the use of automatic recoil wheel brakes such firing would have been impossible, as this model of brake can only control the motion in the direction of the recoil.

FIRING HEIGHT.

In close relation to the method of control of recoil stands the height of the line of fire, which is not only of importance in regard to the weight of the carriage, but is also decisive in regard to its resistance during firing, for the reduction of the jump and for its stability in transportation. Whereas the elevation of the line of fire of the earlier carriages was over 1.1 m. (43.3 inches), the Krupp factory has reduced the height in the newer rapid-fire carriages to about 0.9 m. (35.5 inches) by carrying the axle of carriage through the flasks, or bending it, instead of securing it under them.

By way of experiment the axis of the gun was set level with the carriage axle. (Imperial German Patents 53,773 of May, 1890, and 85,751 of August 28, 1894.) Retaining the height of fire at 0.9 m. (35.5 inches) necessitated giving the wheels a diameter of 1.8 m. (71 inches), which made them correspondingly heavier. Their weight amounted to 91 kg. (200 pounds) each, as against 73 kg. (160.5 pounds) of a similarly constructed gun having wheels of 1.37 m. (54 inches) diameter. Such high wheels, which reduce the jump and the burying in the soil after firing and are also favorable for transportation, prohibit the use of the same size of wheel for limber and carriage, otherwise the weight of the carriage would be unnecessarily increased and for travel the turning facility reduced. Moreover the durability of wheels with a diameter of 1.8 m. (71 inches) and weight of 91 kg. (200 pounds) traveling over rough ground is still uncertain, whereas wheels of 1.37 m. (54 inches) diameter, weighing 73 kg. (160.5 pounds) have been proved to be of sufficient strength.

It is not desirable to reduce the height of firing line below 0.9 m. (35.5 inches) because manipulation becomes more difficult, owing to the chief parts of the gun being no longer in right proportion to the height of the gunner. The front and rear sights would require lengthening too much in order that unevenness of ground and field crops should not interfere with aiming. The lengthening of front and rear sight can be a cause of damage from firing the gun itself, as well as from the enemy's shot, collisions, etc. Too low a line of fire would be injurious to the gun as a vehicle, because the muzzle and lowest parts would be so near the earth that comparatively slight inequalities of ground would cause striking.

In Krupp's guns, the line of sight is at least 2 caliber above the axis of the piece. The height above ground of the line of sight is therefore about 1.05 m. (41.4 inches). With this it is possible during firing to remain sufficiently far back of the crest of the hill, and still to aim over the front and rear sights.

AIMING GEAR.

A further means to simplify manipulation and to increase readiness of fire, lies in the application of the traversing gear, used previously in different artilleries, and by Krupp for the first time in 1860, which makes it possible for the gunner to change, within certain limits, the aim, even without altering the position of the trail—that is, without having to come to an understanding with the cannoneer serving that part of the gun. Rapidity of fire still depends largely upon the cleverness of the latter, as he should obviate the necessity for radical corrections by the gunner. In some respects his task has become more difficult as every method of checking the recoil renders the trail harder to move. The traversing mechanism used on the first rapid-fire guns built by Krupp's factory, applied also in simple form on a 4-pounder field gun built in 1866, in connection with a top carriage with forward pivot, carrying the gun and elevating device, is typical of the Krupp rapid-fire field carriages, but it is by no means the only model tested or used by Krupp. The question is partly solved where only the gun, or the gun with a small portion of the top carriage, moves laterally, partly where the whole carriage, or the greater part of it, participates in the motion. In both cases the center of motion can be applied either in front or rear. Among others, the guns shown in Plates II, IV, V, and VI are provided with movable top carriages with front pivot. A model in which there was no top carriage, was built by Krupp's factory, for a 6-pounder field gun, in 1860. The gun had the usual horizontal trunnions, and lay with these in a support which could turn, with a disk-shaped under surface, in a corresponding socket, secured to the upper sides of the wooden flasks. The breech of the gun rests on the aiming shelf and can be pushed sideways on the latter, by a lever-sort of traversing device. Another model with-

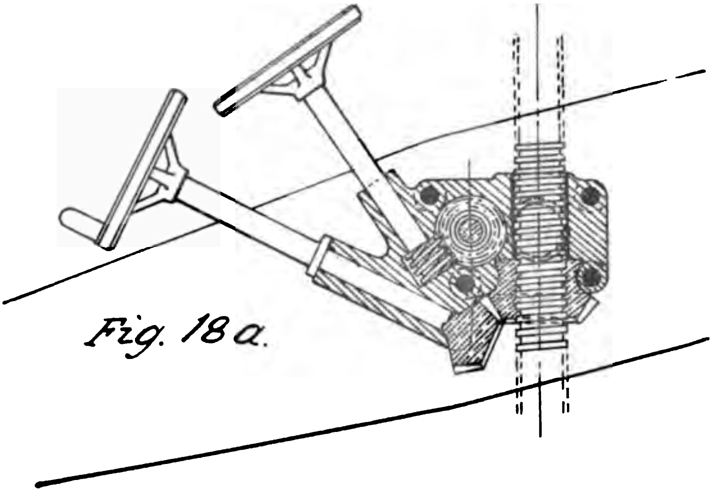


Fig. 18a.

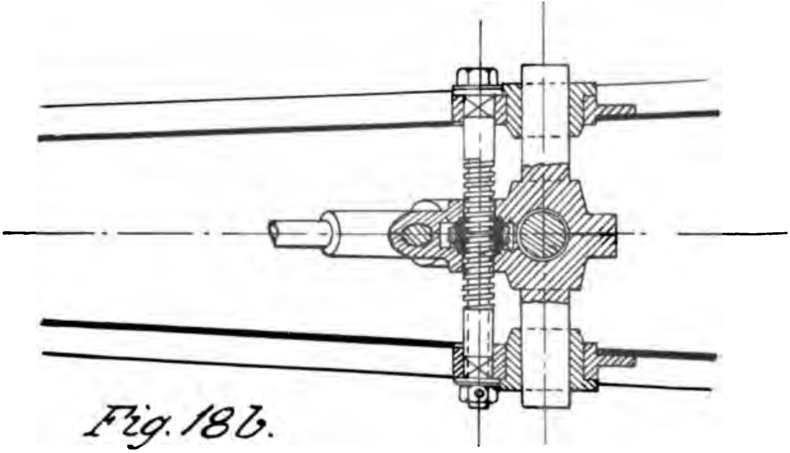


Fig. 18b.

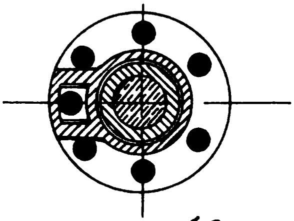


Fig. 18c.

out top carriage, was used later, among others, on the 6.5-cm. (2.56-inch) gun. In this model the gun rested with two vertical trunnions in a ring fitted with horizontal trunnions which enveloped it, serving as a gun support. The breech of the gun is without an aiming shelf, but is connected with the elevating screw, which latter slides (as shown in figs. 18*a*, 18*b*, and 18*c*) on the spindle of the traversing device. (Imperial German Patents 73,012 of December 25, 1892, and 85,928 of January 5, 1895.)

An arrangement similar in respect to the combining of elevating and traversing devices, but differing as to support of the gun, has been tested on the 8.4-cm. piece (Imperial German Patent 54,029 of April 13, 1890). The gun has horizontal trunnions and an aiming shelf, which pivots around a point in the axis of the carriage, for side movement. This combination of the traversing and elevating gear has the advantage of reduced weight, but also the drawback that the traversing gear is severely strained by firing. Its breaking would render the gun useless. The union of the traversing and elevating gear interferes furthermore with the accuracy of fire because, of whatever design such a combination may be, the amount of correction for errors in horizontal as well as vertical direction will vary with the various positions of the piece on its carriage, the consequence being much greater inaccuracy of fire. Finally, the durability of this combination with extensive transportation is doubtful, whereas with the use of the oscillating top carriage the traversing gear is but little strained.

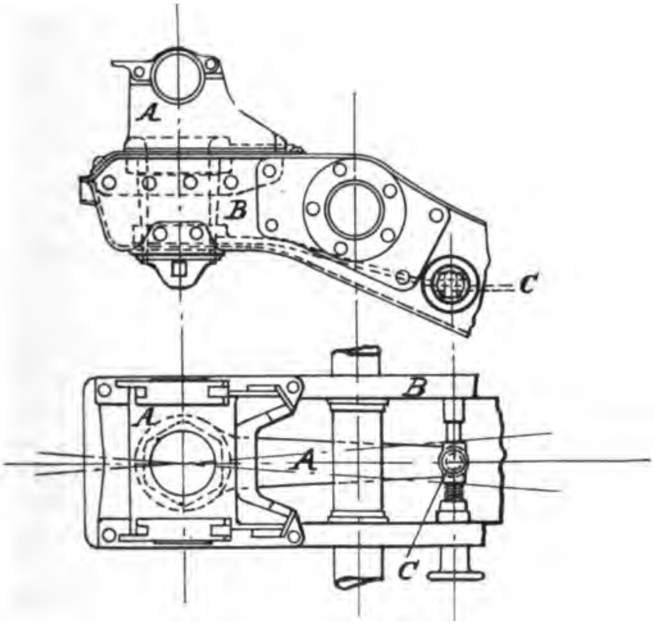


Fig. 19.

[The use of traversing gear, as well as that of vertical trunnions, was formerly known. For instance, the French "Canon a balles" (1867) had such a construction. Instead of the two vertical trunnions of the Krupp model it had only one, and this was placed on the underside of the gun. The trunnion of the gun revolves in an aiming shelf or tray, provided with horizontal trunnions, to the rear end of which the traversing gear is fastened, so that it grasps the breech of the gun. It can also slide back and forth on the bearing surface of the aiming piece. (Reglement pour le service des bouches à feu de siège et place II ième partie. Paris, 1890; p. 106)].

Especially satisfactory results have been obtained with a new Krupp model, shown in fig. 19, in which the top carriage is replaced merely by a pivot fork with trunnion beds. The pivot fork *A* revolves horizontally by means of traversing gear *C*, which is attached to the main carriage *B*. The elevating gear and the aiming shelf are also both attached to the main carriage. Moving the traversing gear causes the breech to slide on the bearing surface of the aiming shelf. One drawback is common to all these traversing mechanisms, and it increases with the increase of the energy of recoil. It consists in the fact that when the gun is traversed to one side, the direction of recoil is at an angle with the median line of the lower carriage. As a results of this, the wheel on the side toward which the muzzle is turned rises farther from the ground than the other; moreover, the carriage inclines to jump toward the opposite side. The consequent change of direction increases according to the degree of traverse of the gun, and after correction by means of the traversing device, this relation becomes more unfavorable, so that the limit of lateral movement is reached sooner than is desirable. It is useless to increase very much the angle of traverse, as it can only be done at the sacrifice of the lightness or the smooth working of the carriage. The accuracy of firing of the gun suffers with extreme traverse. Krupp's factory, after numberless tests, has found sufficient a maximum angle of traverse of 6 to 8 degrees. It is another question whether this angle is to be divided equally, 3 degrees to 4 degrees either side of the middle. Considering that in the direction of twist of the rifling the front carriage shows greater inclination to jump than in the other direction, it would be well for pointing the gun to this side to allow only reduced traverse. In fact in some of the newest Krupp carriages the mentioned 6 degrees to 8 degrees are not divided equally, but so that in case of righthand twist, the muzzle can be turned slightly more to the left than to the right.

If the top carriage is so arranged that the pivot is in the rear, so that the traversing devise is on the front of the carriage, the line of gun recoil on the trail comes nearer to the median line of the carriage, making the conditions for lateral movement of the carriage more favorable; however, this arrangement makes the convenient application of the "handwheel" of the traversing gear difficult, and necessitates a clamp on the front of the top carriage to connect it with the under carriage and increases the weight of the whole. Moreover, in traversing the gun the friction is increased, making it move more slowly and heavily.

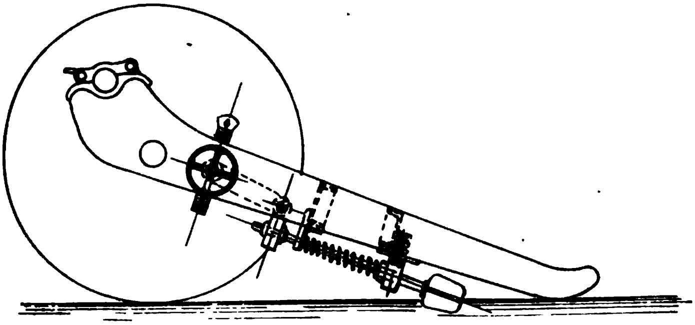


Fig. 20.

The second kind of traversing device, that which allows the whole carriage or the chief part of it to participate in the movement, was made experimentally with the pivot in front and a shaft running between and under the flasks, parallel with them, on the lower end of which, near the trail, was a paddle wheel. The shaft and wheel could be turned by a handwheel placed near the elevating device.

The 8-cm. (3.15-inch) gun, No. 2, of Table III, was experimentally fitted with such an appliance (see fig. 20). The attempt was unsuccessful. The intention of moving the trail sideways by means of the paddle wheel could only be realized on very hard ground. On other ground the wheel stirred up the soil without carrying the carriage with it.

The second hybrid, traversing of the greater part of the carriage body around the trail, has been tried on the 8-cm. (3.15-inch) gun. It is a model, the principle of which has long been known

(Imperial German Patent 7,771, granted to Messrs. H. and E. Eichwede in Hanover, February 11, 1879, and which is shown in fig. 21.

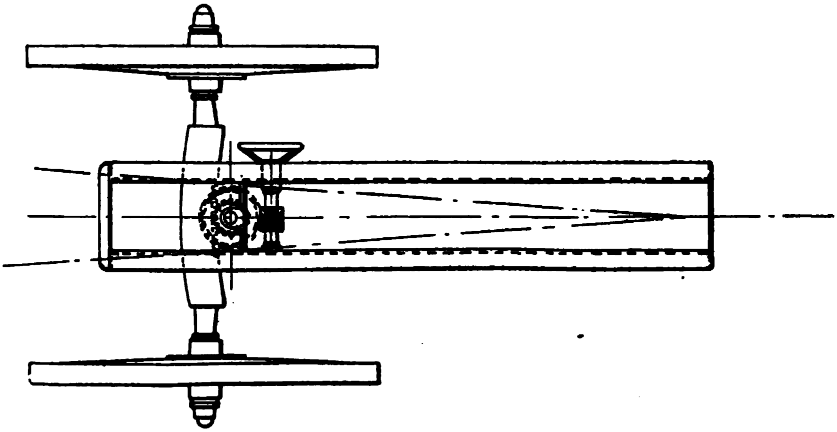


Fig. 21

It involves a curved carriage axle. The main carriage and gun can make a slight side movement on this curve by means of a handwheel, with shaft and worm, which latter engages the teeth made on the axle. The drawback of this system is, that almost the whole weight of the gun must be moved, and that for a very slight angle a considerable movement must be made. The difficulty of moving becomes greater the less smooth and clean the sliding surfaces and the gearing can be kept. Owing to these drawbacks the taking of a side aim requires so much time that the arrangement rather decreases than increases the rapidity of fire. Only in very light mountain guns can the device be used with any advantage. In field guns the system is much to be criticised, because of the lack of a strong connection between the main carriage and the carriage axle.

(To be continued.)

A COMPARISON OF THE HOLDEN AND SMITH CHRONOGRAPHS.

By F. A. Willcox and C. R. Borland.

In the July 1896 number of *Arms and Explosives* a lecture given by Mr. R. W. S. Griffith on the testing of Smokeless Powder was published. In that lecture there is a very full account of the Smith Chronograph and its method of working, and also some very interesting results of the time taken by shot to travel up the barrel of a shot gun.

In the course of his lecture Mr. Griffith refers to the Boulengé Chronograph and points out some of the disadvantages of this instrument which render it unfit for work in an explosive factory.

1. A reading can only be effected between two points at a time.
2. Residual magnetism.
3. The records of time cannot be taken with the desired amount of fineness.
4. Rate of fall depends upon altitude.
5. Resistance of the air cannot be allowed for.

Mr. Griffith considered the 3rd disadvantage the most important and rightly so.

We had the advantage to have in our laboratory a Smith Chronograph and also probably the best type of Boulengé Chronograph, namely that designed by Major Holden, F. R. S., and built by Pitkin.

While carrying out some experiments to determine the time of ignition in American Rifles, it was decided to endeavor to employ the Holden Chronograph as well as the Smith Chronograph for the purpose in view.

The Smith Chronograph, as Mr. Griffith has very rightly pointed out, is suitable for the measurement of short intervals of time such as the period occupied from the releasing of the hammer to the exit of the projectile from the muzzle in the case of a rifle.

The Holden Chronograph is usually considered to be most suitable for the measurement of longer periods of time such as the time occupied by a projectile travelling over a range of 60 yds.

It must be admitted that this instrument has practically no rival for accuracy in measuring such intervals of time and we hope to show below that this instrument is also quite as accurate as the Smith Chronograph for the measurement of small intervals of time, such as those for which the Smith Chronograph is usually employed.

We chose as a problem which would afford us a means of comparing the two instruments, the estimation simultaneously on the two instruments of the exact interval of time between the instant when the firing pin strikes the primer and the instant when the projectile leaves the muzzle in a 40–65–260 Winchester Repeating Rifle.

The method of working the Smith Chronograph has been very clearly described by Mr. Griffith, consequently we may proceed at once to the description of the arrangement of the Holden instrument in order to measure short intervals of time.

It is well known that short intervals of time can be measured on the original Boulengé Chronograph by placing the short rod electro magnet on a level with the long rod magnet and taking advantage of the higher velocity of the registering rod in order to get a more accurate estimation.

The same method was employed with the Holden Chronograph. A bracket was fitted to the top of the column which enabled the short rod magnet to be placed on a level with the long rod magnet and by breaking the short rod current first the measurement is made near the top of the long rod, which is travelling at a relatively high velocity. On the side of the Holden Chronograph is a scale; the position chosen was such that the short rod magnet was at the position 18.88 inches.

It is now necessary to consider what are the limits of accuracy of the instrument when employed in this manner. The accuracy is limited by the following considerations:

1. The accuracy with which the scale can be read: It is claimed that the position of the cut made by the knife on the stick can be read accurately to .001 in. We are inclined to think this correct but at any rate it can be read accurately to .002 in.

Now the whole of the readings in the experiments described below occur between 20.123 in. and 19.743 in. a difference of 0.380 in.

20.123 in. corresponds to 32.002807 secs.
19.743 in. " " 32.009730 "

Difference of .003077 "

0.001 in. corresponds to .0000081 secs., or in other words if the position of the cut can be read accurately to .001 in., the time as far as it is limited by this consideration can be read accurately to 8/1,000,000 secs., and since the position of the cut can be read accurately to .002 in. the time as far as it thus limited can be read accurately to 16/1,000,000 secs.

Again consider the accuracy of the instrument over the whole scale as determined by this consideration.

Making use of the Boulengé table of times we have:

1.0 mm. 0.014278 sec.
1.1 mm. 0.014975 "
0.1 mm. = 0.000697 sec.
.001 in. = .025 mm.
.001 in. = .000174 sec.

Again 520 mm. = 0.325585 sec.
520.1 mm. = 0.325616 "

0.1 mm. = .000031
.001 in. = .000008 sec.

Assuming that the position of the cut can only be read accurately to .002 in. in the most inaccurate position, the instrument gives readings accurate to $\frac{34}{100{,}000}$, or .00034 secs.

But since the readings for small periods of time are all taken at the most accurate position we are safe in saying that the instrument is accurate to .000016 sec.

2. The next consideration is the variation of disjunction, and this determines the limits of accuracy of the instrument.

In order to make the discussion of the effect of this variation clear it will facilitate matters to describe our method of working. When estimating the time of ignition in a rifle, we first make all connections and take a disjunction, then without disturbing the connections hang up the rods again and fire the shot.

Example.—The estimation of time taken from the explosion to the exit of the projectile from the muzzle in a 40–65–260 Rifle:

Disjunction 20.123 in.
Shot 19.806 in.
20.123 in. = .002807
19.806 in. = .000251

Time up barrel .002556 secs.

Same period estimated on Smith Chronograph .0025 secs.

Now if ten rounds be fired it is found that the disjunction varies. We give below the variation in 15 different series of 10 rounds each in sec.

(1)	.00019	(6)	.00015	(11)	.00014
(2)	.00022	(7)	.00006	(12)	.00056
(3)	.00008	(8)	.00020	(13)	.00023
(4)	.00016	(9)	.00013	(14)	.00012
(5)	.00015	(10)	.00064	(15)	.00016

It will be noticed that in one case (10) the disjunction varies .00064, but this does not limit the accuracy of the instrument to this extent—for the contacts have been broken and resistances varied 10 times, whereas in making our estimations the resistance is not changed from the time the disjunction is taken until the shot is fired.

In order to see to what extent the disjunction varies under the conditions of working, two series of disjunctions ten each, were taken, the muzzle and breach contacts remaining the same.

Series	(1)		(2)
Maximum	20.128 in.		20.108 in.
Minimum	20.100 in.		20.082 in.
G. D.	0.028 in.	G. D.	0.026 in.

At the part of the scale .028 in. = .000224 secs.

Since we only get a variation of .000224 secs. while taking ten disjunctions it is reasonable to conclude that during the short period between taking the disjunction and firing the shot the disjunction does not vary more than this and it is highly probable that it varies less—therefore we may state that the instrument is certainly accurate to .00025 secs.

With regard to the accuracy of the Smith Chronograph the designer only claims that it is accurate to .0002 secs. It is certainly impossible to read it with any pretense to accuracy to .0001 secs., and in our opinion it is only possible to put its accuracy at .00025, that is it can be read to ¼ of a vibration, with a lens. Of course with the wedge divider a greater degree of accuracy can be obtained, but for ordinary work in an explosive factory such as measuring the time up the barrel, the accuracy is the same as that of the Holden Chronograph. The Chronograph used in these experiments was fitted with a fork giving 1000 vibrations per sec.

Having established the limits of accuracy of the two chronographs we proceeded to estimate the period of time between the instant *when the firing pin strikes the primer* and the bullet leaves the muzzle in the 40–65–260 Winchester Repeater.

Many estimations have been made of the "time of ignition," as it is named, in shot guns and rifles, but these vary with different experimenters according to the method of breaking the contact at the breech. For instance in the case of rifles, some experimenters attach a wire to the hammer, so that on pulling the trigger the wire is stretched and broken, but in this case we cannot say whether the wire is broken at the beginning or middle or end of the stroke of the hammer. In the same way with these estimations generally there is no exact starting point. To fix an exact starting point we chose the instant when the firing pin strikes the primer.

In Fig. 1 the apparatus is described. The contact is broken at the breech by the hammer striking against the arm A and shaking the rebounder.

The arm A is capable of adjustment so that the hammer can be made to strike it at various positions in its course.

In preliminary experiments it was found that with the arm in one position the "time of ignition" was .0025, in another .0016 secs.

It is obvious that if the first result was correct in the second case the hammer struck the firing pin before the rebounders broke the contact—consequently it was necessary to fix a position of the arm such that the contact was broken when the firing pin struck the primer.

To do this the make and break contact described in Fig. 2 was made from an empty shell.

Now by connecting the rebounder to one magnet of the Holden and the chamber contact to the other magnet, if both contacts are broken at the same time the mark on the rod will be in the same position as the disjunction mark.

The magnets were connected up in this manner and the positions of the arm adjusted so that on allowing the hammer to fall a cut was produced in the same position as the disjunction cut.

The readings are given below :

Rebounder connected to short rod of Holden Chronograph.

Chamber contact connected to long rod of Holden Chronograph.

	Disjunction taken by disjunctor.	*Disjunction taken by falling hammer.*
	20.118 (1)	20.124 (2)
	20.124 (3)	20.121 (4)
	20.150	20.142
	20.095	20.092
	20.128	20.128
	20.072	20.100
	20.092	20.135
	20.100	20.100
	10.104	20.104
	20.104	20.087
	20.078	20.105
	20.114	20.146
	241.279	241.384
Mean	20.106	20.115

These readings were taken alternately.

The difference is .009 in., or .000072 sec., within the limits of accuracy of the instrument. Therefore by this arrangement we are sure that the breech contact is broken exactly at the moment when the firing pin strikes the primer.

It is next necessary to prove that the Smith rebounder breaks at the same time as the Holden rebounder—if such is the case on connecting the two rebounders to the Holden magnets or the Smith magnets a disjunction reading should be obtained.

Smith rebounder connected to Holden long rod.
Holden " " " short rod.

	Disjunction by disjunctor.	*Disjunction by falling of hammer.*
	20.038	20.041
	20.039	20.040
	20.035	20.031
	20.046	20.037
	20.049	20.045
	100.207	100.194
Mean	20.041	20.039

Difference .002 in. well within limits of accuracy—readings taken alternately.

We have now proved that both chronographs start from the same point, the instant when the firing pin strikes the primer.

The muzzle contact is composed of two wires in the same ver-

tical plane 1/32 in. apart, which are broken at the same time. To prove this the Smith muzzle contact was connected to the Holden short rod and the Holden muzzle contact to the Holden long rod. On firing the gun a disjunction reading ought to be obtained.

The readings were as follows:

Disjunction by disjunctor.	*Disjunction by breaking muzzle wires by projectile.*
20.068	20.083
20.068	20.074
20.074	20.074
20.068	20.065
20.067	20.067
100.345	100.363
20.069	20.072

Difference .003 in.

Readings taken alternately.

We have now proved that the breech contacts are broken at the instant when the firing pin strikes the primer, and also the muzzle circuits are broken simultaneously. We now substitute a cartridge for the chamber contact and estimate the time of ignition in the rifle. The results are given below in two tables.

40-65-260 Winchester Repeater Rifle.
Standard American Black Powder Ammunition.
Estimation of Times of Ignition by the Smith & Holden Chronographs Simultaneously.

SMITH.		HOLDEN.			
No.		Disjunction.	Shot.	Time.	Time Corrected.
1.	.00225	20.007	19.807	.002251	.00225
2.	.00250	20.144	19.795	.002801	.00275
3.	.00250	20.123	19.806	.002556	.00250
4.	.00225	20.081	19.806	.002210	.00225
5.	.00250	20.080	19.809	.002186	.00225
6.	.00250	20.100	19.770	.002665	.00275
7.	.00250	20.092	19.745	.002804	.00275
8.	.00250	20.092	19.745	.002804	.00275
9.	.00250	20.073	19.767	.002406	.00250
10.	.00250	20.060	19.786	.002200	.00225
	.02445				.02500
Mean	.002445			Mean.	0025

Mean within limits of accuracy—

Smith Chronograph .0025 sec.
Holden " .0025 "

40-65-260 Winchester Repeater Rifle.
Standard American Smokeless Powder Ammunition.
Estimation of Times of Ignition by the Smith & Holden Chronographs Simultaneously.

SMITH.		HOLDEN.			
No.		Disjunction.	Shot.	Time.	Time Corrected.
1.	.00250	20.122	19.789	.002684	.00250
2.	.00225	20.097	19.818	.002241	.00225
3.	.00225	20.078	19.809	.002166	.00225
4.	.00250	20.093	19.755	.002719	.00275
5.	.00225	20.123	19.827	.002387	.00250
6.	.00250	20.053	19.775	.002249	.00225
7.	.00250	20.065	19.772	.002360	.00225
8.	.00250	20.058	19.833	.002618	.00225
9.	.00275	20.095	19 757	.002719	.00275
10.	.00225	20.082	19.810	.002188	.00225
	.02425				.002400
Mean	.002425			Mean	.002400

Mean within limits of accuracy—
Smith Chronograph .0025 sec.
Holden " .0025 "

We conclude from these experiments that for the laboratory of a powder works the Holden and similar types of the Boulengé Chronograph are more suitable than the Smith Tram Chronograph for these reasons:

1. For measuring the time of ignition in shot guns and rifles the results are as accurate as those obtained by the Smith Chronograph under ordinary conditions.
2. For measuring velecities over long ranges such as 100 ft. the Holden Chronograph, while giving accurate results, can be worked much more quickly than the Smith Chronograph.

This investigation was carried out in the laboratory of the American E. C. & Schultze Gunpowder Co.

Table of Times of Ignition for Holden Chronograph Used with the Left Magnet at 19.88 in. Connect Left Magnet to Hammer and Right to Muzzle.

Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.
16.653	29.3652	16.873	29.5589	17.094	29.7514	17.315	29.9427
657	3687	877	5624	096	7549	319	9461
661	3721	881	5658	100	7583	323	9495
665	3756	885	5693	104	7617	327	9529
669	3791	889	5727	108	7651	331	9563
673	3826	893	5762	112	7685	335	9597
677	3860	897	5796	116	7720	339	9631
681	3895	901	5831	120	7754	342	9665
685	3920	905	5865	126	7788	346	9699
689	3964	909	5900	130	7822	350	9733
693	3999	913	5934	134	7856	354	9767
697	4034	917	5969	138	7891	358	9801
701	4068	921	6003	142	7925	362	9835
704	4103	925	6038	145	7959	366	9869
708	4138	929	6072	149	7993	370	9903
712	4173	933	6106	153	8027	374	9937
716	4207	937	6141	157	8062	378	9971
720	4242	941	6175	161	8096	381	30.0005
724	4277	945	6210	165	8130	385	0039
728	4311	949	6244	169	8164	389	0073
732	4346	953	6278	173	8198	393	0107
736	4381	957	6313	177	8243	397	0141
740	4415	961	6347	181	8267	401	0175
744	4450	964	6382	185	8301	405	0209
748	4484	968	6416	188	8335	409	0243
751	4519	972	6450	192	8369	413	0277
755	4554	976	6485	194	8404	418	0311
759	4588	980	6519	200	8438	421	0345
763	4623	984	6554	204	8472	425	0378
767	4667	988	6588	208	8506	429	0412
771	4692	992	6622	212	8540	433	0446
775	4727	996	6657	216	8574	437	0480
779	4761	17.000	6691	220	8608	441	0514
783	4796	004	6726	224	8643	445	0548
787	4830	008	6760	228	8677	449	0582
791	4865	012	6794	232	8711	453	0616
795	4899	016	6829	236	8745	457	0650
799	4934	020	6873	240	8779	460	0684
803	4968	024	6897	244	8813	464	0717
807	5003	027	6932	248	8847	468	0751
811	5037	031	6966	252	8881	472	0785
815	5072	035	7000	256	8915	476	0819
819	5106	039	7034	260	8949	480	0853
823	5141	043	7069	264	8984	484	0887
827	5175	047	7103	267	9018	488	0921
831	5210	051	7137	271	9052	492	0955
834	5244	055	7172	275	9086	496	0989
838	5279	059	7216	279	9120	499	1023
842	5313	063	7240	283	9154	503	1056
846	5348	066	7275	287	9188	507	1090
850	5382	070	7309	291	9222	511	1124
854	5417	074	7343	295	9256	515	1158
858	5451	078	7377	299	9290	519	1192
862	5486	082	7412	304	9325	523	1226
866	5520	086	7446	307	9359	527	1260
870	5555	090	7450	311	9393	531	1293

Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.
17.535	30.1327	17.775	30.3383	18.015	30.5425	18.255	30.7455
539	1361	779	3417	019	5459	259	7489
543	1395	783	3450	023	5492	263	7522
547	1420	787	3484	027	5526	267	7555
551	1462	791	3517	031	5559	271	7588
555	1496	795	3551	035	5592	275	7621
559	1530	799	3585	039	5626	279	7654
563	1564	803	3618	042	5659	283	7687
567	1598	807	3652	046	5693	287	7721
571	1631	811	3685	050	5726	291	7754
575	1665	814	3719	054	5759	294	7787
579	1699	818	3753	058	5793	298	7820
582	1733	822	3786	062	5826	302	7853
586	1767	826	3820	066	5860	306	7886
590	1800	830	3853	070	5893	310	7919
594	1834	834	3891	074	5926	314	7952
598	1868	838	3925	078	5960	318	7985
602	1902	842	3958	082	5993	322	8018
606	1935	846	3992	086	6026	326	8052
610	1969	850	4025	090	6060	330	8085
614	2003	854	4059	094	6093	334	8118
618	2037	858	4092	098	6126	336	8151
622	2070	862	4125	102	6159	340	8184
626	2104	866	4159	106	6193	346	8217
630	2138	870	4193	110	6226	350	8250
634	2171	874	4225	114	6259	354	8283
638	2205	878	4259	118	6293	358	8316
642	2239	882	4292	122	6326	362	8349
646	2272	886	4326	126	6359	366	8382
650	2306	890	4359	129	6393	370	8415
654	2340	893	4393	133	6426	374	8448
657	2374	897	4426	137	6459	378	8481
661	2407	901	4460	141	6492	382	8514
665	2441	905	4493	145	6526	386	8547
669	2475	909	4527	149	6559	390	8580
673	2508	913	4557	153	6592	394	8613
677	2542	917	4590	157	6625	398	8636
681	2576	921	4624	161	6659	402	8679
685	2609	925	4657	165	6692	405	8712
689	2643	929	4691	169	6725	409	8745
693	2677	932	4724	173	6758	413	8778
697	2711	936	4757	177	6791	417	8811
701	2744	940	4791	181	6825	421	8844
705	2778	944	4824	185	6858	425	8877
708	2812	948	4858	189	6891	429	8910
712	2845	952	4894	193	6924	433	8943
716	2879	956	4934	197	6957	437	8976
720	2913	960	4958	201	6991	441	9009
724	2946	964	4991	204	7024	445	9042
728	2980	968	5025	208	7057	449	9075
732	3013	972	5058	212	7090	452	9108
736	3047	976	5091	216	7123	456	9141
740	3081	980	5125	220	7157	460	9174
744	3114	984	5158	224	7190	464	9207
748	3148	988	5192	228	7223	470	9240
752	3181	992	5225	232	7258	474	9273
756	3215	996	5258	236	7289	478	9306
760	3249	18.000	5292	239	7323	482	9339
764	3282	004	5325	243	7356	486	9342
768	3316	008	5359	247	7389	490	9405
771	3349	011	5392	251	7422	494	9438

Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.
18.496	30.9471	18.736	31.1473	18.976	31.3463	19.216	31.5440
500	9504	740	1506	980	3496	220	5473
504	9537	744	1539	984	3528	224	5505
508	9570	748	1571	988	3561	228	5537
512	9603	752	1604	991	3593	231	5570
516	9636	756	1637	995	3626	235	5602
520	9669	760	1670	999	3658	239	5634
523	9702	763	1702	19.003	3691	243	5666
527	9734	767	1735	007	3723	247	5699
531	9767	771	1768	011	3756	251	5731
535	9800	775	1800	015	3788	255	5763
539	9833	779	1833	019	3821	259	5796
543	9866	783	1866	023	3853	263	5828
547	9898	787	1898	027	3886	267	5860
551	9932	791	1931	031	3918	271	5893
555	9965	795	1964	035	3951	275	5925
559	9998	799	1997	039	3983	279	5957
562	31.0031	803	2029	043	4016	283	5989
566	0063	807	2062	047	4048	287	6022
570	0096	811	2095	051	4081	291	6054
574	0129	815	2127	055	4113	295	6086
578	0162	819	2160	059	4145	299	6118
582	0195	823	2193	063	4178	303	6151
586	0228	827	2225	067	4210	307	6183
590	0261	831	2258	071	4243	311	6215
594	0293	835	2290	075	4275	315	6247
598	0326	839	2323	079	4307	319	6279
602	0369	842	2356	083	4340	323	6312
606	0392	846	2388	086	4372	327	6344
610	0425	850	2421	090	4405	331	6376
614	0457	854	2453	094	4437	335	6408
618	0490	858	2486	098	4469	339	6430
622	0523	862	2519	102	4502	343	6463
626	0556	866	2551	106	4534	346	6505
630	0599	870	2584	110	4567	350	6537
634	0621	874	2616	114	4599	354	6569
638	0654	878	2649	118	4631	358	6601
642	0687	881	2681	122	4664	362	6634
645	0720	885	2714	126	4696	366	6666
649	0753	889	2747	130	4729	370	6698
653	0785	893	2779	134	4761	374	6730
657	0818	897	2812	138	4793	378	6762
651	0851	901	2845	142	4826	382	6795
655	0884	905	2877	146	4858	386	6827
659	0917	909	2910	149	4891	389	6859
663	0949	913	2942	153	4923	393	6891
667	0982	917	2975	157	4955	397	6923
671	1015	920	3008	161	4988	401	6956
674	1048	924	3040	166	5020	405	6988
678	1081	928	3073	168	5053	409	7020
682	1113	932	3105	173	5085	413	7052
686	1146	936	3138	177	5117	417	7084
700	1179	940	3171	181	5150	421	7118
704	1212	944	3203	185	5182	425	7146
708	1244	948	3236	189	5214	429	7181
712	1277	952	3268	193	5247	433	7213
716	1310	956	3301	196	5279	437	7245
720	1343	960	3333	200	5311	441	7287
724	1375	964	3366	204	5343	445	7309
728	1408	968	3398	208	5376	449	7341
732	1441	972	3431	212	5408	453	7373

Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.
19.457	31.7405	19.697	31.9358	19.937	32.1299	20.177	32.3228
461	7437	700	9390	940	1330	181	3260
465	7469	794	9422	944	1362	185	3291
468	7502	708	9453	946	1394	189	3323
472	7534	712	9485	952	1426	193	3354
476	7566	716	9517	956	1457	197	3386
480	7598	720	9549	960	1489	201	3417
484	7630	724	9581	964	1521	205	3449
488	7662	728	9613	968	1552	209	3480
492	7694	732	9645	972	1584	212	3512
496	7726	736	9677	976	1616	216	3543
500	7758	740	9709	980	1647	220	3575
504	7790	744	9740	984	1679	224	3606
507	7823	747	9772	988	1711	228	3638
511	7855	751	9804	992	1743	232	3669
515	7887	755	9836	996	1774	236	3701
519	7919	759	9868	20.000	1806	240	3732
523	7951	763	9900	004	1838	244	3764
527	7983	767	9932	008	1869	248	3795
531	8015	771	9964	012	1901	252	3827
535	8047	775	9990	016	1933	255	3858
539	8079	779	32.0028	019	1964	259	3890
542	8111	782	0059	023	1996	263	3921
546	8143	786	0091	027	2028	267	3953
550	8175	790	0123	031	2060	271	3984
554	8207	794	0155	035	2091	275	4016
558	8239	798	0187	039	2123	279	4047
562	8271	802	0219	043	2155	283	4079
566	8303	806	0251	047	2186	287	4110
570	8335	810	0283	050	2218	291	4142
574	8367	814	0314	054	2249	295	4173
578	8399	818	0346	058	2281	299	4205
582	8431	822	0378	062	2313	303	4236
586	8463	826	0410	066	2344	307	4268
590	8495	830	0442	070	2376	311	4299
594	8527	834	0473	074	2407	315	4331
598	8559	838	0505	078	2439	319	4362
602	8591	842	0537	082	2471	323	4394
606	8623	846	0569	086	2502	327	4425
610	8655	850	0601	090	2534	331	4457
614	8687	854	0632	094	2565	335	4488
618	8719	858	0664	098	2597	338	4519
622	8751	861	0696	101	2629	342	4551
625	8783	865	0728	105	2660	346	4582
629	8815	869	0760	109	2692	350	4614
633	8847	873	0791	113	2723	354	4645
637	8879	877	0823	117	2755	358	4676
641	8911	881	0855	121	2787	362	4708
645	8943	885	0887	125	2818	366	4739
649	8975	889	0918	129	2850	370	4771
653	9007	893	0950	133	2881	373	4802
657	9039	897	0982	137	2913	377	4833
661	9061	901	1013	141	2945	381	4865
665	9103	905	1045	145	2976	385	4896
669	9134	909	1077	149	3008	389	4928
673	9166	913	1109	153	3039	393	4959
677	9198	917	1140	157	3071	397	4990
681	9230	921	1172	161	3102	401	5022
685	9262	925	1204	165	3134	405	5053
689	9294	929	1235	169	3165	409	5084
693	9326	933	1267	173	3197	412	5115

Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.	Inches.	Seconds.
20.416	32.5147	20.440	32.5335	20.464	32.5522	20.488	32.5710
420	5178	444	5366	468	5554	492	5741
424	5209	448	5397	472	5585	496	5773
428	5241	452	5428	476	5616	500	5804
432	5272	456	5460	480	5648	504	5835
436	5303	460	5491	484	5679	508	5867

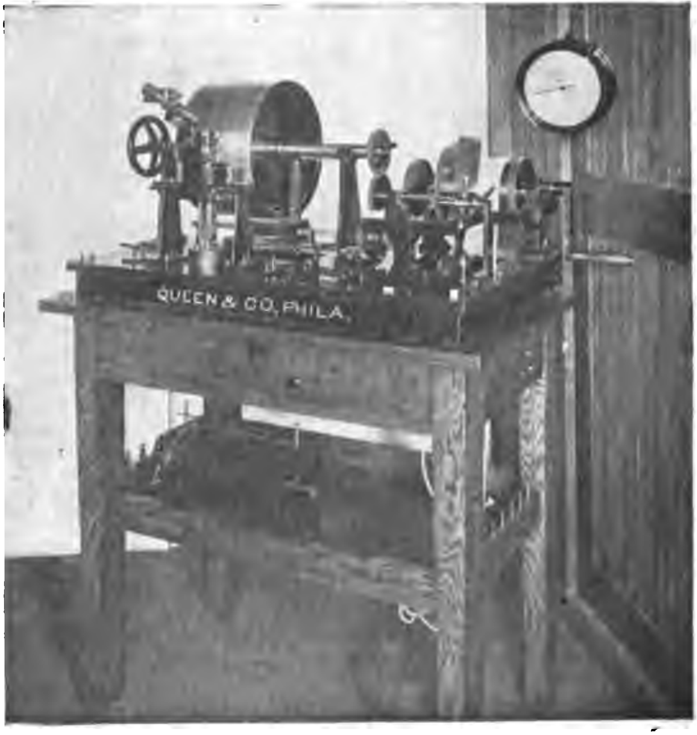
PROFESSIONAL NOTES.

BALLISTICS.

The Queen-Schultz Chronoscope.

The Queen-Schultz chronoscope is a modification of the chronoscope originated by Captain Schultz, of France, for the purpose of determining exceedingly small intervals of time. This form was particularly designed for measuring the velocity of projectiles while traveling along the barrel of a gun.

A drum, one metre in circumference, and covered with a coating of lampblack, is driven by the means of a clock movement and weight, so as to revolve once per second and at the same time slowly advance longitudinally. In front of the drum, mounted on a support and actuated by two magnets, is a standard tuning fork, vibrating 250 times a second; on one link of this fork is a quill which traces a line on the blackened surface of the drum, and therefore will record 250 complete vibrations for every revolution of the drum.



CHRONOSCOPE.

A telescope with micrometer is also attached to the support fork, and each vibration of the fork, traced on the drum in form of a curve, can be subdivided in 1000 parts, thus allowing readings to be made to 1/250,000 of 1 second. On the support with the tuning fork is a small pointer which traces a straight line on the drum. This pointer has an electrical connection with an accurate chronometer which at every half-second closes the circuit and causes the pointer to make a succession of records on the revolving drum. These marks serve as starting points to count the number of vibrations of the tuning fork, and to check them up every half-second.

In order to measure the velocity of projectiles, the gun must be fitted along its bore with special electrical circuit breakers, usually placed one foot apart. Each circuit breaker is so constructed that the current is interrupted as the projectile passes, but is made again before the projectile reaches the next breaker one foot further on.

These breakers, with appropriate battery, are all in one circuit with the primary of an induction coil. One terminal of the secondary of the coil is grounded to the frame of the chronoscope, while the other terminal consists of a fine point near the blackened surface of the drum. Therefore, when the primary circuit is opened by the first circuit breaker along the bore of the gun, the spark induced in the secondary of the induction coil jumps from the points to the revolving drum, leaving a distinct mark on the blackened surface. As the next circuit breaker in the gun is passed, the spark again passes to the drum, and this operation is repeated for every breaker along the gun bore. Thus on the drum, alongside of the indications made by the tuning fork, will be recorded a succession of spots at certain distances from each other. The time elapsing between any two of these spots can be calculated directly from the record which the tuning fork made, and thus the time (measured to the 1/250,000 part of a second) taken by the projectile in passing a known distance along the gun barrel calculated.

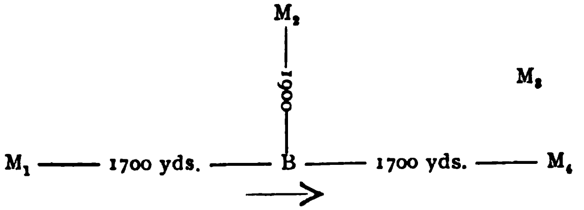
—*Electrical World and Engineer*, June 23, 1900.

The Belleisle Experiment.

The *Belleisle*, her leaks having been plugged and some of the water in her pumped out, reached Portsmouth dockyard.

We will now proceed to examine the firing. As we mentioned last week, the vessel was subjected to nine minutes' consecutive firing, instead of the series of two minutes' fire that formed the original programme. Why the change was made is not quite clear; it is generally regretted, as there was rather to much "killing the dead horse" about it for at least half the period. That is to say—saving for one hit—practically everything of moment was accomplished in the first two or three minutes.

The following diagram represents the course and range:—



The *Majestic* steaming firing from M_1 to M_3, the *Belleisle* (B) being moored with her bow in the direction of the arrow. All the serious hits appear to have taken place between M_1 and M_2. The *Majestic* steamed at six knots.

There being considerable doubt as to the sequence of hits, saving that the second 12-inch shot hit the belt amidships, and that the funnel was knocked out when the Majestic was at M_1 or thereabouts, we propose simply to take them in the sequence in which they registered themselves upon the hull.

So far as can be ascertained, the *Majestic* fired:

8 rounds	12-inch common she
7 "	12-inch A. P. shot
About 100 "	6-inch lyddite (at bow and battery)
About 100 "	6-inch common (at stern)
400 "	3-inch various
750 "	3-pounder shell

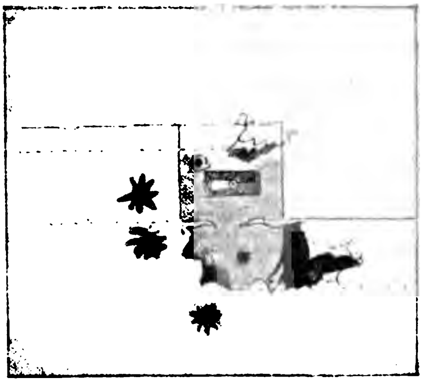
And an indefinite number of Maxims. No torpedoes were discharged. Full charges were used throughout for all guns.

Roughly speaking, about 30 to 40 per cent. of the projectiles fired were effective, the rest went over or just short, or else went clean through and burst beyond. Only about 10 per cent. of the projectiles were clear misses outside the black-and-white haystack of smoke that shrouded the target.

Here, perhaps, we should recapitulate the data of the *Belleisle*. She is of about 5000 tons displacement, and the iron armor is disposed as follows:

Belt	12-inch—6-inch.
Battery	10-inch—8-inch.
Redoubt below battery	9-inch—8 inch.
Conning tower	12-inch.

The belt rises about 2 ft. to 2½ ft. above the water line, but at the time of the trial about 4 ft. were shown. The conning redoubt is octogonal like the battery. The conning tower is situated under the bridge on top of the battery; it is very low, and the hood stood at least 18 inches above the walls. The erection in the bow, which has been generally believed to be the conning tower, turns out to be nothing but the seamen's "head," with, we believe, a lamproom in the upper story.

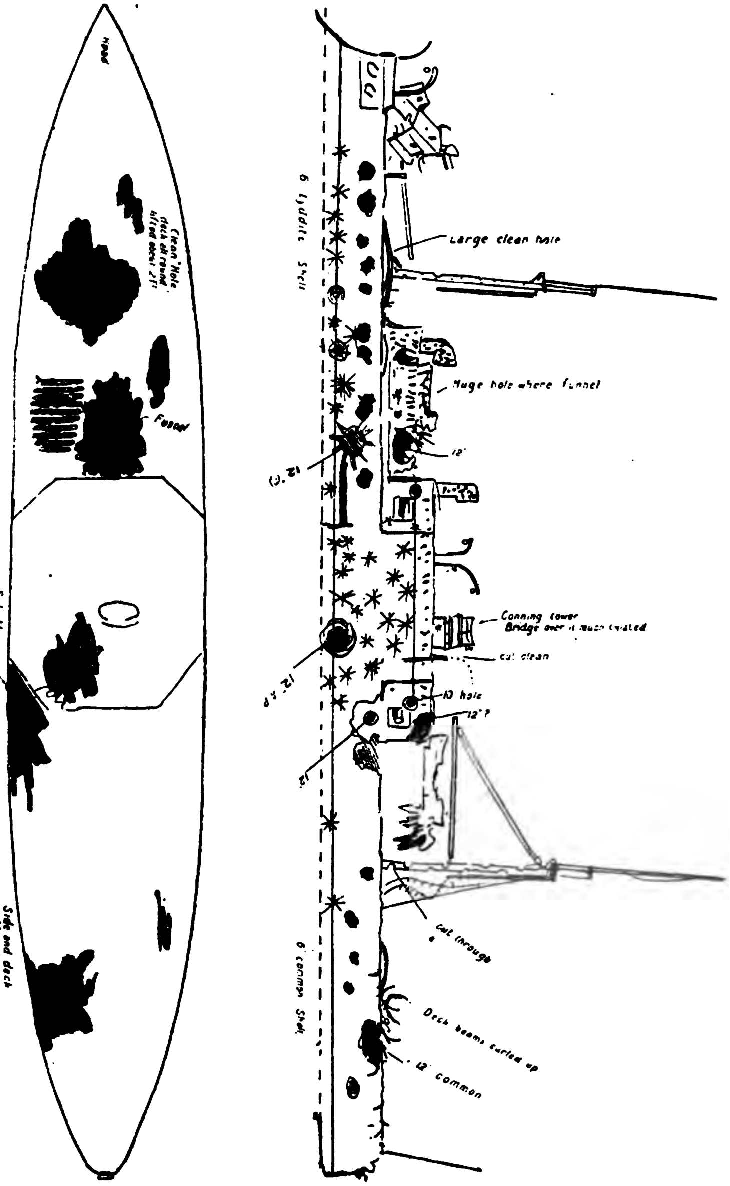


Penetration of bulkhead—port side—with side of ship in front of it torn away. Presumed to be a 12-inch common shell.

Taking the 12-inch hits first, the demolition of this erection in the bow—clearly visible in the photograph by Symonds and Co., of Portsmouth—is variously attributed to a 12-inch and a 6-inch. We think, however, that it was due to one of the latter. On the belt, below where the funnel used to be, there are two very large stars where shell have burst. One or both these are presumably 12-inch hits, there being in one case—the after one of the two—a 12-inch penetration of about 2 inches deep. The armor belt just below is cracked laterally for some 7 feet, and a vertical seam has also opened. The lateral crack is about 6 inches wide. There are the marks of a 6-inch shell in the aperture. The other hit has no mark beyond the large star caused by the burst.

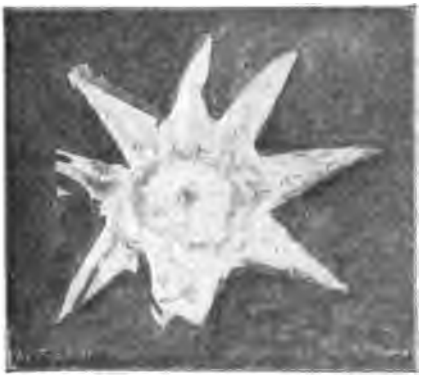
On the water-line, directly under the battery, there is a large hole made by a 12-inch. This is plugged, and inspection is not yet possible. This hit was that by which the ship eventually sank; though not, as erroneously supposed, the direct cause of her sinking. As we have said above, it was the second

12-inch projectile fired. It is probably the prime cause of the crack a little more forward, as this hit blew the right side in, sending one fragment of armor right up through the flat armored deck above it. It did not, however, send anything down into the engine-room. We have not been able to learn where the shot went after going through the belt, which here offered a resistance equal to from 9-inch to 12-inch Harvey, because it was struck at a considerable angle—one, indeed, in which we might conceivably have expected the shot to glance off.



H.M.S BELLEISLE — DIAGRAM SHOWING THE DAMAGE DONE.

Immediately abaft the casemate a 12-inch shell has hit. This shell has blown away some 10 feet square of side, which here looks something like the ruins of a recessed port. In the armored bulkhead there is a penetration, made either by the head of this shell or by a 6-inch shell that did not burst on impact.

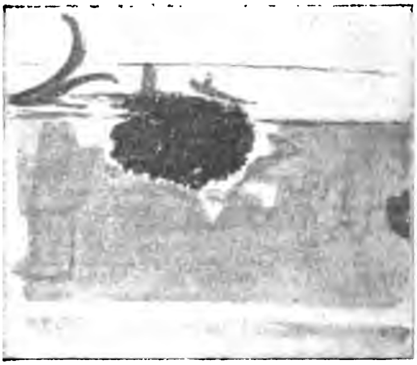


Sketch of a lyddite mark—where a shell burst full against the armor, bnt made neither penetration nor dent. The majority of blows had this effect.

Well aft another 12-inch shell has hit. Here too, a large piece of side is blown in, the deck above has disappeared, and the iron deck beams are curled up into shapeless remains more like shavings than anything else. The external area of damage is about 10 feet; internally the whole of the cabins hereabouts were reduced to matchwood.

There remain two more hits that may be 12-inch. As we observed at the beginning of this article, there are so many hits, so many close together, and such complete destruction about their immediate areas, that the projectile cannot always be named to a certainty. But at the after end of the unarmored top of the battery, and towards the after end of what little remains of the funnel base, there are huge irregular holes, averaging perhaps 5 feet to 7 feet each. Most of the edges are bent inward.

We now come to the most mysterious hit of any. High up on the port side after porthole is a clean, nearly exactly circular penetration of exactly 10 inches in diameter. There is around it an irregular depression, with a maximum depth of 2½ inches, and some 2 feet across at the widest. What made this hole no one seems inclined to be positive about; and, for the present at any rate, we prefer to leave it to conjecture. The head of a 12-inch projectile, a 6-inch lyddite, and a fragment from the hole in the side below, have all entered into the conjectures of those who have seen the hole, but not been allowed to inspect it closely. And here we may mention that on the upper and outer edge of the after port, on the starboard side of the battery, another projectile that is not very traceable has chipped out a piece of armor, and burst, judging by the marks. This is the total of the big projectiles; three of them certain, and five of varying degrees of doubt.



A 12-inch common shell—aft port side—rough sketch of hole and twisted beams.

The bow and battery were fired at by 6-inch lyddite, the 6-inch common shell were directed aft. Between the damage done by one and the other there is no comparison. Both have made holes in the unarmored ends; both have done no harm at all to armor, both have made matchwood of the woodwork inside. But while the 6-inch common has destroyed as one might destroy a wooden box with an axe, lyddite has pulverised completely. Practically there are no remains beyond a dust. The lyddite has acted in a moment much as dry rot acts in a score or two of years. The deck in places is simply gone, and the edges have just the crumbled appearance of dry rot. In other places, too—to use another homely simile—the wood looks like the ends of a deal board that has been heavily hit by a hammer. This exactly gives the curiously compressed appearance. It is noteworthy that there is not a single sign of charring. It is not merely that no burnt wood is visible, there are no signs of scorching either, though possibly a week's bleaching under the sun may account to some extent for this.

Where 6-inch common shell have burst between decks, the deck above shows no signs of it, but it is quite another story with lyddite. Not only are huge holes blown upward, but the entire deck is bulged up. The cross beams were thick and plentiful, but their resisting power has been nil.

The 6-incn holes of entry and exit along the main deck side are all plugged, so no description of them is yet possible. In the diagram they are all indicated by black spots, armor penetrations by a spot surrounded by a circle, shell bursts against armor by a star. These stars along the water-line are very numerous, and effectually disposed of the theory that a water-line can hardly be hit. The extreme bow is absolutely untouched, then comes a series of stars innocent of the slightest dent. Abreast of the funnel—curiously enough just where the armor is thickest—there are several dents where shells have gone in an inch or two. Many shells have burst against the battery, and this, being painted white, looks from a little distance as though it had been covered with Japanese naval flags. There is a great sameness about these shell marks, many of which are almost absolutely identical, and most are symmertibal in shape.

The only remaining boat, stern view. Effect of a common shell bursting inside it. The shell came from the left side. (This boat was simply a bundle of firewood atter the shooting.

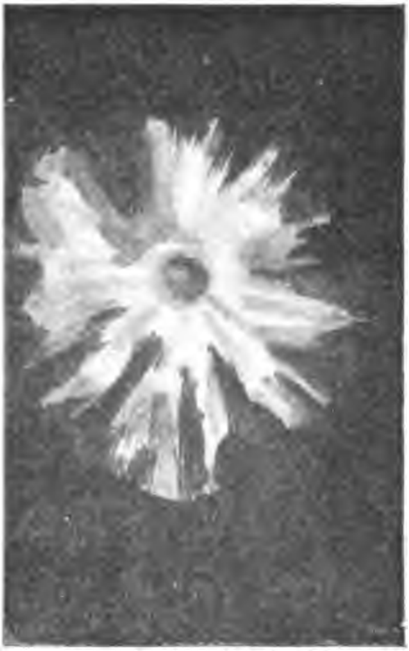
The masts are in a bad way. The foremast is the least damaged. The yard now on it was placed for signalling purposes after the firing, the yards on both masts were shot away, and both peaks were dropped. The mainmast is especially in a very bad way, and had to be shored up. It was cut in two all but a tiny piece, low down, and remained standing only because all the shrouds were not destroyed.

The only boat left is the steam pinnace carried between the battery and mainmast. A 6-inch common shell entered this boat and blew the starboard side of it out into a number of shapeless streamers. It is absolutely clear that no ordinary boats will float after an action; it is doubtful if they will exist.

The damage to the funnel cannot well be described, as there is nothing there but an enormous hole, with strips of iron twisted over it. In the photograph a wood screen will be noted built around this aperture.

The bridge, though much bent and twisted, survived; but the searchlight was blown away. The conning tower was not hit at all. It had inside it some thin wooden dummies—mere laths of wood—so badly put together that the concussion of shells bursting on the topside shook them to pieces. The story about a shell having hit the tower and done this has no foundation in fact.

The upper works were blown to pieces, the 6-pounders either knocked clean away or else blown sideways with some of their fittings melted. Ventilators and so forth were pitted with innumerable small holes from splinters and fragments.



Mark of a lyddite shell that burst against the armor and also made some penetration.

Inside the battery, in which at least one shell that had entered a porthole had burst, all the gun sights were destroyed. The guns themselves are absolutely unhurt; but owing to damages to sights and gear, would have been of no use at all. The dummies aronnd them were all burned.

It is worth noting that two davits have been cut clean in two by projectiles. A great many small projectiles embedded themselves in places, and a few still so remain. Most, however, were shaken out.

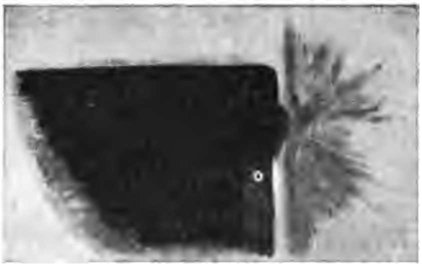
Directly firing ceased the ship was boarded by fire parties and by the officers told off to inspect her. She was then full of dense smoke, caused by the exploded shell, by the pierced funnel base, by a few small bonfires of dummies, and a lyddite shell or two had failed to burst properly and were burning. Practically nothing was to be seen for the smoke and fume.

The mysterious 10-inch hole in the battery above the after port hole port side.

It was taken for granted that the ship was on fire, and water was pumped into her. This lowered her freeboard, and the sea then rushed in at the hole on the water-line made by the 12-inch shot. The ship canted heavily, and every one was called on deck, a chief engineer coming up from below having a very narrow escape from death or disablement owing to the damaged capstan head breaking off at that moment. As it was, two stokers sustained injuries. The ship sank just after the last of the exploring party had left her – sunk, not by gun fire in the picturesque fashion the daily papers described, but in a prosaic attemp to extinguish fire.

Some of the *Belleisle's* hoses were still working when the ship was boarded, others were found cut to pieces. Most of the valves and so forth had disappeared.

A side experiment in connection with the *Belleisle* was to test the efficacy of the Douglas leak stopper, which works more or less on the system of an umbrella. For some reason or other, eiter because they were forgotten or through misunderstanding, only two were actually made use of. These were fitted in side holes just before the funnel, and answered with perfect success. It is unfortunate, however, that a far more ample test was not made.



The after port of battery—starboard side (off side)—possibly the burst of the shell that made the 10-inch hole. The gun besides this burst was quite undamaged.

The report about Krupp armor being placed on the battery is pure fiction; this will be done for a future experiment that cannot take place for some time to come. It is said, however, that the work of refitting the *Belleisle* will be taken in hand at once, so that some idea of our capabilities in this direction in war time may be gauged.

Another partial fiction refers to the torpedoes. These were actually in the tubes, and they were also fully loaded except for the pistols. One was found still in the tube, the other was gone. Very possibly it did dive under the *Majestic*, as report has it, but if so it went at a great depth; and the yarn about that ship having to maneuvre to avoid it is pure moonshine. The condition in which the tubes were found is known to only a few officers.

Considerable comment has been caused by the action of the Admiralty in connection with the experiment. After the firing the *Belleisle* was guarded by a cordon of destroyers, many naval officers even were only permitted to view her from fifty yards away. The strictest orders about secrecy were issued; and an enterprising journalist who had approached the ship in a small boat was captured by the destroyer. He was at once searched throroughly, and every piece of paper in his possession torn up. A week later the ship was brought up to Portsmouth harbor in the daytime without a single tarpaulin to hide her. On Sunday she was in dock for anyone to gaze his fill at.

There is a twofold reason. In the first place, the *Belleisle* experiment has been a triumphant vindication of certain British systems of ship construction. The *Bouvet*, *Charlemagne* or *Kaiser Friederich der Dritte*, had any of them been the target, would have fared as badly—very possibly worse—than the *Belleisle;* and there is no reason why that should be concealed. The British, Japanese, United States, and to some extent the Russian and Itatian, are the only navies that count—from the constructional standpoint—in the light of the *Belleisle* experiments. The second reason is a more curious one. Mr.

Goshen's antipathy to his critics in the Press is well known, and he has recently found himself in a very bad way in connection with them. Unfortunately for themselves, the daily Press as a body have committed themselves to a great many absurd and fictitious statements in connection with the *Belleisle.* To have placed the *Belleisle* on view is a very masterly flank attack upon the persecutors of the Admiralty, and we are afraid, one that will have rather too much significance by-and-bye.

—*The Engineer*, July 8, 1900.

BOOK REVIEWS.

The Story of the Soldier by Brevet Brigadier-General George A. Forsyth, U. S. Army, (Retired). Illustrated by R. F. Zogbaum. New York: D. Appleton and Company. 1900. Pp. 389. $1.50.

The Story of the Soldier is the latest volume of the *Story of the West* series, the preceding volumes being, repectively, the story of the Railroad, Cowboy, Mine and Indian, and those to follow, the story of the Trapper and that of the Explorer.

The part played by the soldier in the advance of civilization over the great west is sufficiently important to give him the first place in the series, for without him, the other three great agents (after the explorer and the trapper) viz: the railroad, the cowboy and the mine, would have been impossible. He was in reality the advance guard of civilization, and his main duty consisted in preserving law and order there where the strong arm of the Civil Law could not as yet assert its power.

This work of the army is the subject of General Forsyth's story, and a fascinating tale it is, told in simple language, but full of incident and adventure from the inception of the army in the Minute Men of the Revolution to the surrender of Chief Joseph to General Miles.

Perhaps the most interesting chapters of this story of the soldier are those describing the remarkable adventures of Lewis and Clark (both regular army officers) in their exploring expedition (1804-6) from St. Louis up the Missouri River, across the Rocky mountains and down the Columbia River to the Pacific Ocean; Lieutenant Pike's trips up the Missouri; Colonel Kearney's march from Fort Leavenworth through what is now New Mexico and Arizona to California at the opening of the Mexican War; and Colonel P. St. George Cooke's from Santa Fé over the same route, constructing a road as he went.

The most important of the Indian Campaigns is also described: the Sioux campaign of 1868-9, the Apache Campaign of 1871-2, the Modoc war, 1872-3, the Sioux Campaign of 1876, and the Nez Percé Campaign of 1877. The accounts of these campaigns, in fact, fill over half the pages of the book; indeed, they comprise the story of the soldier in the opening of the West, and illustrate the character of his work there.

General Forsyth has told the story in a true soldier spirit, with a soldier's admiration for bravery and devotion to duty, but also with a true soldier's appreciation of obedience and discipline. J. P. W.

Commodore Paul Jones by Cyrus Townsend Brady. Great Commander Series. New York: D. Appleton & Co. 1900. Pp. 480.

The great American sailor, whose career and character are set forth in this volume, becomes more and more endeared to us as time goes on, and the deeper we look into his life the higher our respect and the greater our admiration and regard for this born captain of the sea.

As boys, many of us were carried away by the glowing accounts of his exploits in his life by Commodore A. S. Mackenzie, U. S. Navy (published in 1841), an excellent production, to which the author of the present volume also makes his acknowledgements.

Although much has been written on the great commander here described, no extended life had been published for fifty years when the present one was issued (in July, 1900).

The author has practically devoted his life to the study of naval heroes, and has already gladdened the hearts of Americans (especially our boys) with fascinating accounts of their deeds. This new subject, however, has always been his particular admiration, so that he naturally took it up with strong prejudice in favor of his hero; nevertheless, he presents us with an impartial account, which sets forth the great captain's weaknesses and faults unsparingly, to be sure, but with a gentle hand, such as his nature deserves.

The interest of the work is well sustained from cover to cover, and carries the reader along through homely scenes and quiet hours, as well as the dashing hurly-burly of actions at sea, and the manly struggles against injustice, always absorbingly, fascinatingly and delightedly.

Even his efforts to obtain justice are pleasant reading, because we can smile now at the ignorance of those who failed to recognized the worth of such a man, and his trials make us better satisfied with similar acts of injustice today. "Then, as ever, Congress was continually meddling with matters of purely military administration, to the very great detriment of the service."

Farragut, Jones and Dewey are the three greatest American captains, whose magnificent fighting has added such glorious chapters to the history of our naval campaigns, and of these the earliest has the additional charm of being closely associated with the birth and the babyhood of our flag.

J. P. W.

The Diary and Pocket Book for 1901. Aldershot: Gale and Polden Ltd. Price 1 shilling, 6 pence.

This booklet is arranged as a diary, with a half page for every day in the year. It has in addition (what should prove very useful to non-commissioned as well as to commissioned officers), on the respective days of the week, month and year, notices when returns are due, when schools begin, recruits are finally approved, proposals for annual camps are submitted etc.

There is also a complete resumé of the composition of the British Army, with names of all regiments and numbers of all batteries, territorial titles, facings etc., the dates of their going abroad and their return, and much other interesting information.

Anniversaries of British battles are noted throughout the year.

J. P. W.

The Washington Post Almanach and Encyclopedia. 1901. Washington, D. C.: The Post Company. Price, 25 cents.

A remarkable collection of facts covering a multitude of subjects, embraced in a volume of nearly 500 pages. It would be impossible here to give any idea of the field covered by the statistics collected in this work, but perhaps a faint idea of its wide range may be derived from the following headings selected at random:

China and the Boxer War. The Chronology of the Philippine War. The South African War. Athletics and Sporting Record. The Cuban Tariff. Record of Current Events. Some every-day arithmetic. Poisonous plants which children should know.

It will be found useful on the farm, in the household and in the office.

J. P. W.

La Question Militaire aux Etats-Unis. J. N. Bruxelles et Leipzig: Librairie Militaire C. Muquardt. Th. Falk, Editeur. 1887. Pp. 40.

This comprehensive study of the military and naval policy of the United States has acquired a new interest in the face of our late war and the proposed increase and reorganization of our army.

It opens with a consideration of Lieutenant (now Lieutenant-Colonel) Wagner's article in the *Journal of the Military Service Institution* (1886) on the Military and Naval Policy of the United States, in which particular attention is called to the fact that the government has not generally profited by its dearly bought experiences. A very complete résume of the original article is given together with interesting comments.

The author then takes up the article in the same volume of the *Journal of the Military Service Institution* on The Defense of our Coasts by Captain Griffin of the U. S. Engineers (now Vice President General Electric Co.), and gives in brief space a very clear idea of the leading thoughts in that essay.

The article in *Scribner's Magazine* by Captain F. V. Greene, U. S. Engineers (late Brigadier General, U. S. Volunteers) on Our Defenseless Coasts, published about the same time, is spoken of as presenting the subject very forcibly, and the salient points of that work are here presented in some detail, while the ability of its author is clearly recognized.

Finally, the author of this interesting little pamphlet devotes some attention to another article in the *Journal of the Military Service Institution* (1887), viz: that by Professor P. S. Michie, U. S. Military Academy, on the Personnel of the Artillery, and concludes with a referunce to another article in *Scribner's Magazine* (1887) on Our Naval Policy: a Lesson of 1861.

No better collection of essays could be made to illustrate our military and naval policy in its strength and its weakness. J. P. W.

Notes concernant la Guerre Hispano-Américaine par le Général Neyt. Liège: Revue de l'Armée Belge. 1900. Pp. 93.

The author of this work has obtained his data from a number of periodicals, including the *Estudios Militares* of Madrid, the *Journal of the United States Artillery*, *Munseys*, the *Century Magazine*, *Razviedtchik* of St. Petersburg, etc.

It comprises an excellent short account of the events, together with valuable comments on the naval and military strategy and tactics of the campaign. The author has evidently made a careful study of the best authorities, and has known how to sift his material, and thus present the gist of the subject in a tangible form. J. P. W.

BOOK NOTICES.

[These books will be fully reviewed as space becomes available.]

Report on the Census of Cuba, 1899. Lieut. Col. J. P. Sanger, Inspector-General, Director. Washington: Government Printing Office, 1900.

Report of the Committee on State and Municipal Taxation of the Chamber of Commerce of the State of New York. 1900. New York: Press of the Chamber of Commerce.

American Manufacturer and Iron World. Published weekly by the National Iron and Steel Publishing Company, 213 Ninth Street, Pittsburg, Pa. $3.00 per year.

This publication appears in a new and attractive dress this year.

Principal articles in first number: A century of blast furnace practice. The gas engine at the beginning of the twentieth century. Blast furnace slag for fertilizing.

With Seven Generals in the Boer War. Major A. W. A. Pollock. London: Skeffington & Son, 163 Piccadilly. 1900. $1.50.

Soldiers' Traning, and other notes. Major H. de B. Hovell. London and Aldershot: Gale and Polden Ltd. Price 2 shillings.

Views of Aldershot, the Headquarters of the British Army. Aldershot: Gale and Polden Ltd. Price 1 shilling.

Théorie et Tracé des Freins Hydrauliques. M. E. Vallier. Paris: Vve. Ch. Dunod. Editeur. 49 Quai des Grands-Augustins. 1900. Price 4 Francs.

Sulla Teoria delle Travi e dei Lastroni di Cimento Armato. Crescentino Caveglia, Colonnello del Genio. Roma. 1900.

Kriegsgeschichtliche Beispiele des Festungskrieges aus dem deutsch-franzoesischen Kriege von 1870-71. Oberstleutnant Frobenius. Viertes Heft: Artillery Angriff. 1900. Berlin: E. S. Mittler und Sohn. Pp. 88, with maps. $1.00.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6*d each.*

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House. Arundel Street, Strand, London, W. C. Per year 7 *s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12*s* 6 *d.*

Canadian ilitary Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6 *d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6 *d.*

Journal of the Royal United Service Institution. [*Jour. R. U.S.I.*] *Monthly.*,
22 *Charing Cross, Whitehall, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
66 *Russell Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C. Per year* £1 10 *s* 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

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Armée et Marine. [*Armée et Mar.*] *Weekly.*
3 *Place du Théatre Français, Paris, France.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

Le Livre Militaire. [*Livre Mil.*] *Monthly.*
6 *Rue de la Chaise, Paris. Per year* $1.00.

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
6 *Rue de la Chaise, Paris. Per year* 8 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

Revue du Génie Militaire. [*Génie M.*] *Monthly.*
8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

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11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

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Revue des Questions Militaires. [*Quest. Mil.*] *Monthly.*
6 *Rue de la Chaise, Paris. Per year* $3.00.

11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

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Darmstadt. Per year 24 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W., Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Deutsche Land und Seemacht daheim und in den Kolonien. [*Land u. Seemacht.*] *Fortnightly.*
Eisenacherstrasse 60–61, *Berlin, W.* 30. *Per Quarter* 6 *M.*

Illustrirte Aeronautische Mittheilungen. [*Aeronaut. Mitth.*] *Quarterly.*
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Koch Strasse, 68, *Berlin. S. W.* 12. *Per Year* 20 *M.*

Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf. Per year* $5.00.

Umschau, Die. [*Umschau.*] *Weekly.*
Frankfort a. M. Per year 10 *M.*

AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens. [*Mitth. Art. u. G.*] *Monthly.*
Wien, VI, Getreidemarkt 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
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Wien I, Stauchgasse No. 4 *Per year,* 8-14 *numbers,* 6 *Fl.*

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Basel, Switzerland. Per year, 8 *Fr.*

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Rue St. Georges 32, *Ixelles, Belgium. Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
Frauenfeld, Switzerland. Per year 5 *Fr., plus postage.*

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22 *Rue des Guillemins, Liège, Belgium. Per year* 13 *Fr.*

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SPANISH ORDNANCE IN THE DEFENSES OF HAVANA.

When I chose the subject of Spanish Ordnance as the theme of my essay the difficulties which were to attend the obtaining of reliable data were almost unforeseen. My impression was that literature was extant and easily obtainable. I have, however, discovered that I erred in so thinking, at least as to its being easily obtainable. Fragmentary extracts from several naval and military periodicals, I have received, but their contents have generally been such that they afforded nothing very definite or tangible, relating as they do to other conditions than those which actually exist here. That such difficulty should be encountered seems to me rather strange in view of the fact that nothing of the kind is the case when it comes to questions of other ordnance of modern type. This paper must therefore consist of a relation of facts concerning the guns most of which I have ascertained by personal inspection.

In this discussion I shall endeavor to limit my remarks in great part to a consideration only of that class of ordnance in the defenses of Havanna, which, we must suppose, would have been depended upon by the Spaniards for the purpose of making an adequate reply to the fire of our squadron, in the late war, in case a bombardment or attempt at landing had been made; and upon which we would, at the present time, be compelled to place our reliance in event of its being necessary to defend the city against a foreign power. Among the above mentioned class are included a number of more or less familiar type, such as the Krupp and Maxim-Nordenfelt guns; a detailed description of these would perhaps be superfluous in view of the fact that information concerning them is so easily obtainable. I shall endeavor to confine my remarks in great part to a consideration only of that class of ordnance of a distinctly Spanish type, hoping that the subject may not be altogether uninteresting in view of the expressions of opinions which we sometimes hear, both pro and con, as to the value or effectiveness of the guns as defensive weapons.

In speaking of "ordnance of a distinctly Spanish type," I refer only to that manufactured or designed by the Spanish general Ordoñez. This, I am informed, is the only modern gun of Spanish manufacture constituting a part of the armament of the defenses of Havana. In our military notes on Cuba we find it stated that several of the batteries are armed with Hontoria guns of different calibres. So far as the present armament is concerned, this I believe to be a mistake, and it probably is the cause of the generally accepted belief that several classes of modern Spanish ordnance are found here. An inspection of Spanish guns reveals a similarity in all their essential parts; breech-blocks, manner of assembling carriages, etc., all show that they are of single pattern. This of itself is not sufficient to establish their identity as being of Hontoria or Ordoñez manufacture, however, for according to the statement of an ex-Spanish sergeant, these two guns were similar in all their parts, the difference between them consisting only in the metal used in their construction; that the Hontoria is a much superior gun, being entirely of steel, and that they were considered too expensive to be used in the defense of a colonial city.

Each of the seven most important works of Havana contain a number of guns of the Ordoñez pattern. By these I mean those designated as No. 1, No. 2, Velasco, Santa Clara Battery, No. 3, No. 4, and No. 5.

No. 1, situated a few hundred yards from the shore, at a distance of 2600 yards east of Morro Castle, mounts in barbette four 15 cm. Ordoñez rifles.

No. 2, about 1700 yards east of Morro Castle, and at the same distance from the shore line, is a powerful battery of similar pattern. It mounts two 12-inch Krupp guns, four 21 cm. Ordoñez howitzers and two Maxim-Nordenfelt 6-pounders at its extremities.

Velasco, forming a part of Morro, has three 11-inch Krupp guns.

Santa Clara Battery, on the west side of the harbor, at a distance of about a hundred yards from the shore, is said to be the most powerful of all Havana's defenses. Its armament consists of three 11-inch Krupp guns, two 30.5 cm. Ordoñez rifles, and two Maxim-Nordenfelt 6-pounders.

After Santa Clara, at intervals of about 900 yards, 600 yards and 1200, respectively, are batteries 3, 4 and 5, low-lying, redan-shaped fortifications of the same general class as No. 1 and 2. Their armaments are as follows: No. 3, four 21 cm. howitzers, No. 4, two 15 cm. and two 24 cm. Ordoñez rifles; No. 5, four 15 cm. Ordoñez rifles and two Maxim-Nordenfelt 6-pounders mounted at the extremities of the work.

In attempting to prepare a discription of the Ordoñez gun I have chosen as a type, so to speak, the 24 cm. rifle, partly because this is one of the guns mounted in the battery where I am stationed, and partly also because nearly all remarks made concerning this gun will apply with some modification to the other guns of this class.

This gun in its manner of assembling and construction appears most to resemble our early 12 inch mortar with cast iron and steel hoops. It is, however, hard to determine, owing to the dearth of literature, and almost absolutely impossibility of obtaining reliable information, the exact manner of construction of these guns. The tube or body appears to be of cast steel and not cast iron. This casting of whatever nature it may be, is, on the 24 cm. rifle, reinforced by, in all, sixteen steel hoops. These can be plainly traced and counted on both of these guns in this battery. Of these the rear hoop alone appears to be assembled by shrinkage on the body of the gun. The junction between the metal of the tube and that of the rear hoop is at first scarcely distinguishable. This manner of assembling is probably for the purpose of holding the other hoops in their places and also resisting somewhat the longitudinal stress on the tube at moment of the explosion of the powder charge. Four of the hoops beyond the trunnions form a sleeve; this sleeve must so abut against the heavy hoop carrying the trunnions and a shoulder on the tube of the gun as to take up the forward thrust of the trunnions and the backward pull of tube at the moment of discharge; from this we will observe a reversal of the tendency toward relative motion between the tube and the jacket due to the fact that the breech-block of this gun, when closed, screws into the tube and not into the jacket; in our own service the pull of the breech-block is transmitted by means of the base-ring to the jacket the tendency being to pull the jacket backward and to shove the tube forward, and not only at the explosion of the powder, but also while the projectile is pressing through the bore.

The weight of this gun is given as 24926 kilos or about 24 long tons as compared with 30 tons for our 10-inch gun, model 1888. The total length of the barrel is 28.13 feet, as compared with

30.6 feet, for the same gun; the length of the powder chamber is 63.15 inches, as compared with 65.09 inches for the 10-inch gun in our service. The average diameter for the powder chamber is 9.9 inches. I say average for the reason that the diameter has for some reason not been made constant throughout the entire length of the powder chamber. If this were known to be the case with but one of the guns, one might be led to believe that it was due to accident or careless handling of the instruments used; but it is observed in all of the Spanish guns which I have had the opportunity of examining. A longitudinal section is apparently a portion of an ellipse.

The rifling of this gun, I am inclined to believe, is not uniform; this for the reason only that if it is uniform, it is much higher than uniform twists in guns of our service. As a matter of fact, the uniform twist is not used in any of our sea-coast guns, it is generally increasing from one in fifty, to one in twenty-five calibres. A very crude instrument, consisting merely of a wooden disc attached to the end of a shaft of wood, carrying at its other extrimity a circular protractor to the centre of which was suspended a plumb line, gave some results. The disc was made the same diameter as the 24 cm. rifle, and upon its outer edge was fitted a stud of copper, fitting accurately the lands of the rifling of the piece. This wooden shaft was eight and one-half feet in length. By the use of this instrument four points in the development of one of the lands were plotted, one at the breech, one at the muzzle, and two at intermediate points in the bore. The abscissas of this curve, represented the distances passed over by the disc, and the ordinates the number of degrees of turn in the rifling corresponding. The curve showed an increasing twist. If we assume that it is uniform (considering the experiment as too uncertain), then, as before stated, it has a high rate of twist. A number of trials gave eight and one-half feet turn of about one hundred and forty degrees. This, reduced, would give a twist to the rifling of one in less than twenty calibres. The enforcing of such a twist upon the projectile, it would seem, might unduly strain the gun.

A letter from the Chief of Ordnance, states, concerning the 24 cm. gun (Ordoñez), that with a charge of 154.3 pounds of brown prismatic Murcia powder, the armor-piercing projectile, weighing 429.9 pounds, is fired with a muzzle velocity of 1772 feet per second. This information, however, is not according to the powder charges found in the magazines. The weight of the charge prepared by the Spaniards is 145 pounds. The letter probably refers to the maximum charges that would be used in the guns. On this supposition I have used this value for the initial velocity of the 24 cm. rifle, in preparing a range table for the gun, more for the purpose of discussion, as illustrating what might be attained under certain conditions, than for the value it may ever have when it comes to firing the guns.

The breech-mechanism of these guns is somewhat unique when compared with guns of our own service. This consists in the kind of obturator used. The breech-block belongs to the French, or interrupted-screw system, and, as with most guns using this system, we might expect to find a device for checking the escape of gas, similar to that of the Bange or Freyre—particularly since the inventor of one,—Freyre—is a Spaniard.

But not so with this gun, the obturator is similar to that employed in guns of Krupp manufacture, known as the Broadwell ring. It consists, in this case, of an obturator ring, entirely similar to that found in the Krupp system, but instead of the obturator-plate of the latter system, there is substituted another ring of the same interior diameter as the obturator ring. In this substitution alone, does the gas-check differ from that of the Krupp, so far as its parts are concerned. The metal used in the Krupp system is steel, in this it is copper. The operation is precisely the same. The obturator-ring is so shaped, that the heavy gas pressure acting upon its thin forward edge, forces it tightly against the walls of the bore, and forces the rear part backward against the copper ring of the front face of the breech-block. The most important consideration is to insure a close fit between the obturator-ring and the copper ring of the front face of the breech-block. In order to accomplish this the spindle of the breech-block, to which the front face is attached by means of a string nut, is fitted with a series of washers, or discs, of copper, zinc, and coarse paper, all bearing upon a shoulder on the rear part of the spindle. Such a number of these washers is used as will cause the copper ring of the front face of the breech-block to be forced tightly against the obturator-ring when the breech-block is driven home by the action of the screw.

The obturator seems to possess some advantages: it is simple, and not liable to get out of order, in the Krupp gun it has well withstood the test of experiment. As in that gun, its principal defect lies in its tendency toward fouling. In the opinion of many, however, its simplicity compensates for its defects.

To support the screw and jacket system, and the obturating device of the Krupp gun, a very heavy forging is required. The

Ordoñez gun, combining the French and German breech mechanisms, eliminates the necessity of an extra heavy forging, and obtains results as favorable as are obtained in the Krupp.

The breech-block is rotated by means of a simple lever. This would seem to be one of its weakest points. In our service, the lever handle, or a modification of it, is used only with guns of lighter calibre, as in the field and siege guns, the amount of power attained by its use, not being sufficient to rotate the breech-blocks of our heavy sea-coast guns. But this point of difference, must be taken into consideration: the obturator of our guns, be it the Freyre or the De Bange, is in prolongation of the breech-block, and extends well into the powder chamber. The pressure developed by the explosion, causes radial expansion of the steel ring in one case, and of the pad in the other, so that the resistance to rotation and withdrawal is such as to require a special device. In this gun the obturator is not in prolongation of the breech-block, nor does it extend into the powder chamber. The obturator-ring remains in its seat, when the block is withdrawn. The bearing surfaces are all of like metal, steel upon steel, copper upon copper. The rotation of the block, however, of the 24 cm. rifle, is started by means of an auxiliary lever, so fitted as to bear against the main lever, and by its means the block can be sufficiently rotated to insure its entire rotation by means of the main lever.

The tray is of brass, and is similar in many respects, to that used for the heavy guns in our service. It carries no translating screw, however, for rotating and withdrawing the breech-block from its seat, as do our heavy guns. This operation must be done by hand. The amount of muscular effort required, however, is not great, even with the heaviest Ordoñez gun at Santa Clara. A very slight rotation of the block, corresponding to a movement of the Krupp breech-block by means of the locking-screw, frees it entirely. When the piece is horizontal, or slightly elevated, it may be easily withdrawn upon the guide-rails. The side-latch, which holds the tray in place, after the block has been withdrawn, and swung around into position for loading, is similar in all respects to what we ourselves employ. The same may be said of the tray-latch, which holds the tray in place while the tray is being withdrawn from the breech. As with our own guns, this latch is tripped automatically by the block in its outward motion. The vent-cover device is entirely a familiar one.

Each of the guns is supplied with at least two sets of sights, one for each side of the gun. The howitzers, and a number of the guns, are, in addition, supplied with circles graduated for azimuth readings, and carry quadrants on their trunnions for setting off directly the angle of elevation in arc.

The front sight for the guns needs no special mention, being of the same form as is generally adopted. The rear sight consists of a bar of steel, somewhat more than a metre in length. This bar is graduated to read millimetres. The divisions on the bar have been taken to mean ranges, but such, owing to the fact that they are equi-distant throughout the entire length of the sight, cannot be the case. They are in reality the tangents of the angles of elevation of the gun, considering the distance between the front and rear sights measured parallel to the axis as the radius. At the extremity of the bar is mounted at right angles to its axis, a sliding scale, reading to millimetres also. This, owing to the fact, that the graduations in most cases, read only to the left, is evidently for the purpose of correcting for the drift due to rifling. The rear sight-bar fits into and slides up and down in a socket cut through the bronze breech-plate. A movable collar, fitted with a screw, fixes the elevation as desired. It is now only necessary to know accurately the distance between the front and rear sights, in order to calculate the length of rear sight required for a certain elevation. This distance was measured on the 24 cm. rifle, and found to be 2.798 metres. Using this as an argument, it was an easy matter to add a column to the table of fire for this gun, containing the sight lengths corresponding to angles of elevation already culculated as giving certain ranges. I might add here that since this measurement, a number of inaccuracies have been discovered in the positions of the sights on these guns. One of these being that the line of sight as adjusted by the Spaniards, was not parallel to the axis of the bore; another being, that the guiding points of the two front sights, or of the two rear sights were, in no case, in the same horizontal plane. The difference would scarcely be appreciable however, in its effect upon the distance between the sights. Assuming, therefore, the range table correct as worked out from available data, we may now consider the errors which theoretically might arise in the range due to an error in the setting of say one millimetre. At a range of five hundred yards, the least distance considered, we find, by consulting the table of fire, that for a change in range of one hundred yards, there must be a change in the length of rear sight used, of a little more than four millimetres; or, one millimetre of rear sight at this range, corresponds to a little more than twenty yards. As the ranges increase, the increments of sight length increase continuously, until at 8000 yards a change of 100 yards in the range necessitates an increase in the sight length of nearly twelve millimetres. Thus, at this range, an error of the setting of one millimetre would theoretically produce an error in the range of no more than about eight yards. As may be said of everything pertaining to Spanish ordnance, the sight is a simple one, and, leaving inaccuracies of construction out of consideration, good results might be attained by its use.

All of what may be termed the modern sea-coast guns cf the Defenses of Havana, are mounted *en barbette*; not a disappearing carriage is to be found in the city or even in the island. The howitzers are apparently intended for both curved and direct fire, but would be of little use for either purpose in all probability. The carriages of all the guns, except that of the 30.5 Ordoñez, appear to be of rivetted iron plate, very similar to those belonging to some of our muzzle-loading guns. We often hear it said, that they could not be depended upon to stand the shock of the prescribed charges. With respect to the howitzer, there is probably some justification for this assertion, but just where such is apparent in the other cases it is hard to say. It is probably based more upon the outward appearance of the carriages than upon a consideration of what a good carriage ought to be, and what forces it must withstand. They certainly do not appear to an advantage when compared with the carriages of some of our modern sea-coast guns. To make the comparison just, however, we must go further than the carriages. Our 10-inch rifle, model 1888, for instance, which we may compare with the 24 cm. Ordoñez, is a gun of much higher power and requires a stronger carriage. In this gun, 250 pounds of powder and a projectile of 575 pounds weight are used, giving an initial velocity of 1975 f. s., as compared with the quoted maximum of 154 pounds of powder, 429.9 pounder projectile, and 1772 f. s. as the initial velocity of the 24 cm. Ordoñez. The same will be observed when we endeavor to make a comparison between the other Spanish guns and those of corresponding calibres in our service. The question is largely one of speculation and can only be ascertained by experiment. It is said that the guns were all mounted under the immediate direction of the Spanish General Ordoñez, which fact should lend some degree of assurance as to their safety in use.

In general appearance, the carriage of the 24 cm. Ordoñez, resembles that of the old 10-inch centre-pintle gun of our service. The chassis is composed of heavy parellel, rivetted, "I-beam" girders, stiffened by transoms. Its weight is stamped upon an attached plate, as 8078 kg., or about 18000 pounds. Between the rails, and attached to the chassis, is a pair of hydraulic buffers, the pistons of which are attached to the top carriage by means of a stout lug. These buffers belong to the constant pressure and variable orifice system, the liquid used being in some cases a preparation of glycerine, and in others, neutral oil.

The top carriage of this gun, is composed of heavy rivetted iron plates. Its weight is given as 2580 kg., or about 7670 pounds. After firing, the gun is brought into battery by rolling friction, very much the same as our 8-inch converted rifle. The gun is elevated, depressed and traversed, by the usual methods. The entire weight of this gun with its carriage is about 78000 pounds, or 35 long tons; but five tons more than the weight of our 10-inch gun without its carriage.

Passing to the 15 cm. rifle, we find that the only essential point of difference between this gun and the 24 cm. is in the manner of assembling. This gun has no steel hoops, but consists merely of a tube and jacket. The jacket carrying the trunnions, is a single forging, apparently of steel, and is so large that there is room 'for some doubt as to whether it possesses the required physical qualities. In our service, for all guns of larger calibre than the field pieces, it is deemed necessary, though by no means preferable, to make the trunnion-hoop separate from the jacket. The breech-block of this gun, when closed, as in the case of the 24 cm. rifle, screws into the tube, reversing, as in that case, the tendency of relative motion between the tube and the jacket. For this reason I believe that the tube is inserted from the front, while the jacket is expanded sufficiently by heat to allow the shoulders on the front and rear part of the tube to pass through; these shoulders abutting against corresponding ones on the tube, prevent relative motion.

The total length of this gun is 16.65 feet. The length of the powder chamber is 37 inches. That of the breech-block, 9⅞ inches. A letter from the Ordnance Department states, that with a charge of 36.37 pounds of black prismatic Murcia powder, this gun fires its armor-piercing shot with a muzzle velocity of 1673 f. s., the weight of the shot being given as 100 pounds. There is no correspondence between these weights and those actually found in the magazines, so that this value of the initial velocity will only be used for the purpose of discussion.

The largest gun of the Ordoñez pattern, mounted in the defenses of Havana, is the 30.5 cm. rifle, two of which we find in

Santa Clara Battery. This gun, in all its essential particulars, resembles the 24 cm. rifle. Its carriage does not appear to be of iron plates, as those of the other guns of the Ordoñez pattern, but of steel, this difference being necessary on account of the greater size of the gun. A comparison of this gun with our 12-inch gun, will illustrate again the disparity which exists between these guns and those of corresponding calibre in our service. We will consider the 12-inch, model 1888. The total length of the Ordoñez is 32.2 feet; that of the 12-inch gun 36.67 feet; the length of the powder chamber of the 30.5 cm., is 80.4 inches; that of the 12-inch gun 77.33 inches, being greater for the Ordoñez gun in this case than for our own. But the diameter of the 12-inch rifle powder chamber, exceeds that of the Ordoñez gun, by almost two inches, they being, respectively, 14.2 and 12.36 inches; its capacity in cubic inches being 12,092, as compared with 9647 for the Ordoñez rifle, representing an excess of about one-fourth in favor of our gun. A comparison of the powder charges and weights of projectiles used in the two guns, shows the following figures: 352 pounds of brown prismatic powder for the Ordoñez as compared with 450 pounds of the same class of powder for our 12-inch gun; 1000 pounds as the weight of the projectile in our 12-inch gun as compared with 841 pounds, the weight of the heaviest projectiles found in the magazines of the Santa Clara Battery. The muzzle velocity attained by our 12-inch rifle is 1975 f. s.; that of the Ordoñez but 1706, according to a letter from the War Department. The density of loading of the Ordoñez, calculated from the powder charge prepared by the Spaniards. is about 1.01, a little less than that of the 12-inch rifle, which is 1.0285. We might make a number of assumptions as to the equality of the characteristics and constants of the Spanish with our own, and thus show the difference of the pressure developed in the powder chambers of each gun, by the use of the pressure formula. The assumptions would, in all probability, not be accurate however, and we scarcely need to demonstrate the fact that the 24 cm. Ordoñez is a gun of much lower power than the 12-inch rifle, model 1888. Hence we cannot make a direct comparison of the carriages based merely upon appearance.

The only modern curved-fire gun in the fortifications of Havana, is the 21 cm. howitzer (Ordoñez). This gun is assembled very much as is the 15 cm. gun, except that the trunnion hoop is separate from the jacket, which passes under it, as is the case with our 5-inch siege gun. We find four of these howitzers mounted in fort No. 2, and four in No. 3, and they appear as if they were intended for both curved and direct fire. Whatever may be said concerning the weakness of the Spanish gun carriages, would seem to apply to these with more force than to any others. Here we have an 8.27-inch howitzer, mounted upon a carriage which would appear to have been originally intended for a direct fire gun only. The recoil buffers instead of being inclined to the chassis rails, in order to take up the shock of the recoil, are parallel to them, the entire vertical component of the shock, which in general will be greater since the piece will nearly always be fired with considerable elevation, and since the rails are themselves inclined to the front, being transmitted through the top carriage to the chassis. Firing this gun a considerable number of times, with high angles, it would seem, could not fail to greatly damage the carriage, and perhaps render it totally useless. We might assume that the gun is only to be used for direct fire, and thus afford an excuse for the manner of placing the recoil buffers, comparing it at the same time with our 7-inch howitzers, model 1890. The powder chamber of our howitzer, 7.364 inches in length, while that of the gun is 16 inches. The powder charge prescribed for our 7-inch howitzer is 10 pounds of "B. K." granular powder; in the magazines of Battery No. 3, we find four different powder charges prepared for the 21 cm. gun: 6.75, 8, 10 and 12 pounds, all of brown prismatic powder. The initial velocity attained by the 7-inch howitzer projectile, weighing 105 pounds, is 1088 f. s. Now, it is highly probable that the initial velocity of the 21 cm Ordoñez howitzer, is much lower than this: first, for the reason that the maximum powder charge, 12 pounds, is but two pounds more than that used in the 7-inch howitzer, and is of brown powder, the calibre of the gun being 1.21 inches greater than that of our howitzer; second, that the projectile of the 21 cm. howitzer, weighing as it does, 209 pounds, lacks but one pound of being twice as heavy as the projectile of the 7-inch howitzer. Howitzers, with an initial velocity of lower than 1088 f. s., or even as low as this, would never be used as guns of direct fire. The more correct conclusion with respect to these guns, would seem to be, that they were mounted for mortar fire in spite of the fact that the construction of their carriages is so much at variance with sound scientific principles. As such, and arranged as they are in line, they would probably be of no practical use.

The guns of the Krupp and Maxim-Nordenfelt manufacture, in the fortifications of Havana, are well known, and require no special mention.

The two 12-inch Krupps of Battery No. 2, are formibable guns, admirably mounted upon steel carriages. Their emplacements appear to be of the best concrete.

The 11-inch Krupps of Velasco and Santa Clara Batteries, are guns of a somewhat older type, but appear to be quite serviceable.

The Maxim-Nordenfelt 6-pounders of No. 2, Santa Clara and No. 5 Batteries, are in each case mounted at the extremities of the works.

There are a number of other guns, of more or less obsolete type, in addition to those that have been mentioned, but since they would be next to useless in modern warfare, nothing would be gained by describing them.

The projectiles used in these guns, are much the same as those used in all guns of modern type. In the magazines we find the shot, sheel and shrapnel.

Their weights for the different guns are as follows:

For the 24 cm.		
Sprapnel	305	pounds.
Cored shot and common shell, each	439	“
For the 15 cm.		
Shrapnel	92	“
Cored shot	112.5	“
Common shell	94	“
For the 30.5 cm.		
Shrapnel	607	“
Cored shot (two kinds)	833.5	“
Cored shot	837	“
Common shell	841	“

A brief description of each class of projectile, for one of the guns, will suffice for all. I will chose the 15 cm. Of the armor-piercing cored shot, there are two varieties, the tips of which are painted for distinction, red and white. The red tipped shot appears to be of cast-iron, the head of which has been hardened by the chilling process. The white tipped one is probably of steel, marked as it is in Spanish “Perforante.” The dimensions and weights of the two are the same.

The *shrapnel*, filled, weighs 92 pounds, unfilled, 21 pounds, leaving a bursting charge of one pound of powder. This bursting charge is a base charge. The projectile contains 400 balls of chilled lead, each weighing about one ounce. These are packed in the body of the shrapnel, in heavy tallow, no matrix of cast-iron being found in any of the magazines. In its construction it is not of the latest model, being a cast-iron tube, closed by means of a wrought-iron head. Today, as we all know, the shrapnel is either of steel, or of wrought-iron tubing.

The common shell for the 15 cm. gun, is of cast-iron. Filled, it weight 93 pounds, unfilled, 67 pounds, giving a bursting charge of seven pounds of powder.

The bursting charge of both the shell and shrapnel, is of black powder, and in cases that I have examined, the powder has undergone considerable deterioration, having lost the lustre peculiar to black powder, in most cases, in others being reduced to a fine dust.

The contact, or percussion, fuse of the Spaniards, screwing into the tip of the shell, is of the same general type as our own. The time fuse, however, is somewhat different. It combines only the time train and the concussion of the discharge; our combination fuse, combines the three elements, time, percussion and concussion, by means of a double set of plungers. Therefore the Spanish time-fuse, as found in the magazines, cannot, in the strict interpretation of the word, be called, as it frequently is a combination fuse. Instead of its being necessary in this fuse, to punch a hole in the time train, corresponding to a given time, as with our fuse, it is simply necessary to turn a graduated disc attached to the fuse until a pointer upon it indicates the required time.

Concerning the powder used by the Spaniards, information, as we all know, is very meagre. Nothing is obtainable as to its composition, or manufacture. It is known as the Murcia prismatic powder, and we find both the brown and the black grains. The density is given as 1.69.

In a letter from the War Department it is stated that a pressure of from 25000 to 35000 pounds per square inch, is developed in the powder chamber of the 15 cm. rifle, when the 100 pound projectile is fired with a charge of 36.37 pounds of this powder. This information might be of some use, if there were any way of determining the value of the pressure to choose between these limits. The powder beyond a question of a doubt, has undergone changes both physically and chemically since its manufacture, and data known to be correct then, would not necessarily be so now. The powder charges prepared by the Spaniards, and found in the magazines, are generally less than the maximum. In the case of the 30.5 cm. gun, only, does the density of loading approach to unity. The powder charge of the 15 cm. rifle, is seven inches shorter than the powder chamber, and the average diameter of the charge is less than that of the chamber by one inch.

In other words 462 cubic inches, or more than one-third of the volume of the powder chamber, is unoccupied, the density of loading being but .804.

Each of the batteries is supplied with an equipment, more or less complete, of rammer staves, sponges, shot-trucks, trays, etc., the heavy gun-chests containing extra obturator-rings, sights, keys and wrenches of various descriptions. An ample supply of ammunition, shot, shell, shrapnel, fuses, etc., is found in the well-constucted magazines. As to literature, almost nothing remains, no range-tables, no charts, nothing to indicate the time of construction of the forts, the manufacture of the guns, or the use of the various equipments found in the batteries.

We now come to the question of the efficiency of these guns. This will, as in all cases, depend not only upon the manner in which they are served and handled, the courage and intelligence of the gunners and cannoneers, but also upon the power of the guns to do execution, other conditions being as they should be. Of course if the gun carriages used by the Spaniards, are of inadequate strength, as has been held by some, or if the emplacements are of inferior workmanship, as has been maintained by others, if the construction of the guns is such as to render their use a source of danger to the cannoneers, then, as a weapon of defense, they have no value.

As to this, there is, at present, no chance for argument, and certainly nothing is to be gained by making bare assertions based upon mere superficial investigation. For instance, we hear the greatest amount of criticism pronounced upon the 30.5 cm. gun at Santa Clara. It is said that were this gun to be fired with its prescribed charge, it would either burst, be blown from its carriage, or have its emplacements completely shattered. For any reasonable grounds upon which to base such assertions, one would probably look in vain. An examination of the howitzer, will without doubt, reveal some weak points, so far as its carriage is concerned, probably more due to the fact that they were mounted in great haste upon carriages for which they were not originally intended. The worth of the howitzer is not what is questioned, however, but that of the guns, and particularly of the one above mentioned. It seems that we are scarcely going too far, in assuming that even the Spaniards were far-seeing enough to put the guns to a test before depending upon them for the city's defense. I have been informed by residents of the city, that the guns were frequently fired by the Spaniards in all of the batteries, and that considerable time was devoted to target practice.

As to the emplacements, from No. 1 to No. 5 we find them in sound condition. All are of the concrete masonry, and have thoroughly stood the test of the weather. These, with the beautiful workmanship exhibited in the construction of the magazines, should be a lasting tribute to the ability of the Spanish military engineers.

In order to continue the discussion of the efficiency of the guns, then, it will be necessary to conclude that the question of their ability to be used is a settled one, and settled in favor of the guns.

The indeterminate problem of the initial velocity, now presents itself; indeterminate, for the present, at least, for we have not the means of measuring it. For the purposes of discussion I have assumed as correct the values given for this quantity, in letters received from the War Department. These letters consist, for the most part, of extracts from the *Naval Annual* and from the *Revue d'Artillerie*. The muzzle velocities are given, when certain powder charges and certain weights of projectiles are used. As before stated, these powder charges and weights of projectiles in no case correspond with those actually found in the magazines of the batteries, the powder charges being in all cases smaller than those used in determining the quoted initial velocities. By considering the given values as right, we may form some idea of what the power of the guns is under conditions that are probably not abnormal and not unattainable.

Assuming the muzzle velocity of the 15 cm. rifle as 1673 f. s., as quoted, and using this value in computing a range table for the gun, omitting all consideration of drift, and other factors, which can only be determined by experiment, we find that at six thousand yards the remaining velocity of the 100-pound projectile, propelled by a charge of 36.37 pounds of powder, is still as high as 900 f. s., that is, it has not yet fallen off one-half. The striking energy at this range is about 500 foot-tons. According to Captain Orde Brown's rule, which is as follows: "The penetration of a projectile, in wrought-iron armor, is one calibre for every thousand feet of striking velocity," this gun at 6000 yards, should be capable of piercing about five inches of armor, its calibre being 5.93 inches. At 3000 yards, the remaining velocity is 1131 f. s., giving a striking energy of about 900 foot tons. According to the rule, at this range, the gun should send its shot through seven inches of armor, coming in contact with any of the lighter armored parts of a vessel, it would be capable of inflicting great damage.

The 24 cm. Ordoñez, firing its 430 pound shot, with a muzzle velocity of 1772 f. s., is a much more powerful gun. At 6000 yards, the striking velocity of this projectile, propelled by a charge of 154 pounds of powder, is 1100 f. s., representing an energy of 3600 foot-tons. It would be capable of perforating, at this range, about ten inches of wrought-iron armor. At the lesser ranges, the energy of the impact increases as the square of the velocity, and the perforating power of the shot, as the first power of the velocity, if we accept the rule of Captain Brown.

We now come to a consideration of the 30.5 cm. gun, the most powerful of this pattern. Using the given muzzle velocity, 1706 f. s., for the 838 pound shot, we find the striking velocity at 3000 yards, to be 1600 f. s., representing in round numbers, an energy of 15000 foot-tons. Applying the arbitrary rule of Brown's, this shot at 3000 yards, should be capable of piercing the armor of any warship using wrought-iron for its protection. At distances much greater than those at which the fire of ships could probably be effective, the result of a hit from one of these guns, might be disastrous.

Considering the batteries from east to west, in their order, and beginning with No. 1, we may say that this battery, with its four 15 cm. Ordoñez, could sweep the coast from one thousand yards to the eastward and as far as Morro Castle to the westward, or engage the enemy at from three to six thousand yards in its front, with considerable effect. Aided by the powerful 12-inch Krupps of No. 2, which are probably more formidable than the 30.5 Ordoñez, all points falling within the sector of say one hundred and forty degress about No. 1, with a radius of 6000 yards, would be subjected to the fire of the guns of No. 1 and 2. The Velasco Battery, situated almost on Morro Point, should be capable of defending a sector at least as extensive. Santa Clara, with its powerful armament, would bring a much heavier fire upon a somewhat less extensive sector. Following Santa Clara, the guns of Nos. 3, 4 and 5, would extend the fire swept zone well to the westward. If a bombardment of the city were contemplated, or a reduction of its defensive works, it is probable that the attacking squadron would be compelled to come well within the range of nearly all the guns in the harbor, if results commensurate with the undertaking were looked forward to. It did not require the further example afforded by our late war with Spain, to demonstrate the fact that, as yet, fire delivered from ships at long range against modern earth works, is very uncertain, if not a negative quantity. The number of hits upon such low and inconspicuous targets, must of necessity be very small. The order of the day would seem to be, to move up so that the fire of the secondary batteries of the ships would be brought into play, reliance being placed upon them to drive the enemy from his guns. The question is, could a fleet move up with impunity to within a distance of from 1500 to 2500 yards of the batteries of the Havana defenses against the storm of projectiles which would meet their advance? Naval men are probably ready with their answer—the sea-coast men also perhaps. The defense of the city is not my subject, however, only so far as it concerns the efficiency of, and service of the Spanish guns. In order that the guns be properly served, we must have, as in all cases, intelligent men as gunners and cannoneers; we must have a full line of equipment, all the necessary appliances, range-finders, position-finders, range-tables, etc.; we must have a manual for each of the guns, and most of all we must be allowed to actually fire the guns in target practice. Men of sufficient intelligence we have in the rank and file of our army; the equipment in most cases is more or less complete; what we are lacking in this line, we are informed, will shortly be supplied us by the Ordnance Department. A modification of the manual for corresponding pieces in our own service answers very well for these guns. In the order scheduling the drills for the present year it is stated that the artillery season will comprise the months of May and June. Before the practice can begin it would seem that at least an approximate value of the M. V. must be known. This can be determined by experiment; we may measure the muzzle velocity by means of the chronoscope or we may deduce it by the solution of the inverse problem, given the angle of elevation, the ballistic coefficient, and the range to find the M. V. The latter method is probably the more feasible under the present circumstances owing to the fact that the chronoscope would require a relatively large amount of expensive apparatus. To employ the second method we would first have to accept the value .9 for the coefficient of reduction, c, entering the expression for the ballistic coefficient; the error made would certainly be inappreciable, or, at least, well within the error of the gun for the reason that the form of the projectile is entirely in accordance with the latest developments as to air resistance. The determination of the range would require first a base line accurately measured, with observing stations at its extremities; second, an allowance of ammunition in addition to that allowed for target practice sufficient to render it possible to ascertain with considerable accuracy the centre of impact of a series of shots fired under as nearly as possible identical conditions. For observing the fall of the shots, transits may be mounted at the extremities of the base lines, the angles being measured on its horizontal limb. It would seem that the entire work can and should be carried on for each of the forts mounting guns of different calibres by the officers on duty at the forts or at least by a board of artillery officers appointed especially for the purpose. However the work is accomplished, it must be begun sometime in advance of the target season as it will involve a considerable amount of time.

It scarcely seems possible that a better opportunity could present itself than that which is now within the reach of the 2d Artillery for advancing its younger officers and its men to a practical understanding of the necessity of using the same with intelligence and efficiency. Each of the eight heavy batteries of the regiment at the time stationed in Havana, excepting Battery "H" at the Pirotechnia, is in or near the Spanish forts. Granted that the guns are not of the latest model, who can deny that practice skillfully directed with our 8-inch converted rifle in recent years has done much to awaken the long needed interest in sea-coast artillery, making it, as it should be, after the navy, with our immense sea-coast, the principal arm of our country's defense.

Herman W. Schull, 2d Lieutenant, 2d Artillery,
Havana, Cuba.

SHIPBUILDING IN GERMANY, AND THE IMPERIAL GERMAN NAVY.

Compiled from various sources, *Revue Maritime, Brassey's Annual, Notes on Naval Progress, German Reports and Statistics.*

The wish expressed by the celebrated poet Arndt, in his patriotic hymn on the German Fatherland, is being realized: at the present time, the army, the navy and national industry are advancing by immense strides. The mouths of the Weser, the Elbe, the Oder and the Vistula, the great straits of Pillau and of Mensel are defended by remarkable works, and other points of the sea-coast have been rendered impregnable by a complete system of permanent fortifications. At Wilhelmshaven, where formerly not a single ship could be repaired, vessels of the largest size are constructed today.

A few years ago, all or nearly all the steamships employed in the ocean commerce of Germany were built in the shipyards of the United Kingdom. Now Germany builds her own ships and conditions are rapidly changing. For material, the Empire is no longer dependent on foreign countries; all her ships are built in government arsenals and other shipbuilding plants from home products. The engines are also of German manufacture and their boilers are fed with native coal. The German flag, at present, floats on all seas, and is known in the most distant parts of the world.

A memoir, entitled "The Interests of the German Empire," attached to the recent naval reorganization bill, presents very clearly the very considerable development of German interests in all branches of international financial movements.

Thus the population of the Empire, which in 1871 was about 40,997,000 inhabitants, amounted to 53,324,000 in 1897, indicating an increase of 30 per cent. During the same period, commerce with foreign countries increased 60 per cent. Navigation statistics show that the greatest advance in maritime commerce took place from 1873 to 1895 during which period there was an increase of 124% on the tonnage of vessels in German ports.

Maritime commerce which, by itself, represents 65% of the total foreign trade, has developed principally with countries lying beyond European waters; thus there has been an increase of about 128% with the United States; 317% with the two Americas; 480% with the East Indies and the extreme Orient, and about 475% with Australia; while there has been only about 119% with Northern Europe, 88% with England and about 60% with Southern Europe. This state of affairs shows plainly the value of the national trade.

This growing interchange of German merchandise with foreign countries has produced an extraordinary increase in Germany's commercial fleet. According to recent reviews of the commercial fleets of the world, Germany has of late been outstripping England. Her ocean steam fleet gained 248,000 gross tons, and 149,000 tons net in 1899, while England gained only 100,000 gross tons and 20,000 tons net. All other countries were behind Germany in shipbuilding; Italy with 97,000 tons in course of construction, France with 91,000 tons and the United States with 68,000 tons.

In the fall of 1899, the merchant marine of the four leading countries, according to German authority, stood as follows:—

	Steam. Net tons.	Sail. Tons.	Total.
Great Britain and colonies	6,758,000	2,602,000	9,460,000
Germany	1,166,000	548,000	1,714,000
United States	672,000	1,291,000	1,963,000
France	516,000	309,000	825,000

The foregoing shows that Germany now occupies the position which the United States for many years enjoyed, being second to England in ocean steam transportation. Moreover, in spite of many obstacles, Germany has obtained this position in the short period of ten years. This rapid development is to be attributed to the encouragement given by the Government to the shipbuilding interests through liberal premiums allowed the different commercial companies on the construction of merchant vessels.

German commerce is making steady conquests in far latitudes where formerly the English and the French had sole control. If this peaceful advance is to continue—if Germany's position in foreign countries is to become firmer and its industrial importance greater,—there must be behind this commerce a naval force commanding respect. As a German authority says: "In the partition of the Asiatic world we must gain a position in order to open new markets for our commerce. Without a strong fleet, this place will not be conceded to us."

This necessity is forcibly dwelt upon in the draft of the new naval bill (additional to the law of the 10th of April, 1898) urging a further increase: "To the German Empire, the security of its economical development, and more especially of its foreign trade throughout the world, is a vital question. *Under the existing circumstances*, in order to protect Germany's sea-trade and colonies, there is one means only, viz., Germany must have a fleet of such strength that even for the mightiest Naval Power, a war with her would involve such risks as to jeopardise its own supremacy."

Although still young, the German Navy due to its special organization has been able to create in a comparatively short time a force that is not to be disdained. The program of naval constructions elaborated by General von Stosch in 1873 produced at the end of ten years, 28 battleships, including armored gunboats, 20 corvettes, 8 dispatch boats, 18 gun-boats, 5 school ships and 10 torpedo boats.

The year 1888 marked the beginning of the reconstruction of the naval material. At that time, the Chief of the Admiralty, after a study of the different types of ships in service, showed that not one was at the height of recent progress and development, and subsequently obtained an appropriation of 140 millions for new naval constructions. This sum was to be divided among 32 new vessels.

The text of the law presented to the Reichstag on the 1st of December, 1897, adopted the 10th of April, 1898, is a new proof of the great advancement Germany intends giving her navy.

The Reichstag in this bill is asked to vote all expenses for the Imperial Navy for seven years, that is until 1904.

A *resumé* of the bill is as follows :—

Material.—The strength of the Navy, excluding torpedo-boats, training-ships, gunboats and special service vessels is fixed at:

a. Vessels for active service: 17 battleships, 8 coast defence ships, 9 large and 26 small cruisers.

b. Reserve: 2 battleships, 3 large and 4 small cruisers.

To attain this, it becomes necessary to distribute over the budget for each year, the appropriations required for :

1. New constructions contemplated above, so that the program may be finished by 1904.

2. Constructions intended to replace other ships which will have to be put out of service as follows: for battleships and coast-defence ships replacement will take place after 25 years service; for a large cruiser, after 20 years, and for a small cruiser, after 15 years.

3. The maintenance of a fleet for duty along the coast of Germany, composed of an active squadron of 9 battleships, 2 large and 6 small cruisers; a reserve squadron of 4 battleships, 4 coast defence ships, 2 large and 5 small cruisers; and a reserve division, in commission only two months of the year, of 2 battleships or 2 coast defence ships.

Finally, according to the needs of the service, each year's budget will carry the sums necessary for the torpedo-boat service, gunboats, ships on foreign station, training-ships, and those on special service.

Personnel. The necessary personnel including non-commissioned officers, warrant officers, sailors and marines, is to be calculated on the following basis:

1. The crews required for vessels on foreign station plus one-half that number.
2. Complete crews for the active squadron intended for duty on the German coast, for one half the number of torpedo boats, for all training-ships, and for all ships on special duty.
3. Two-thirds of the required number of engineers and one-half crew for the reserve squadron and for the other half of the torpedo-boats.
4. The necessary personnel for land service and for duty at arsenals.
5. Finally, an increase of 5% on the total personnel as above determined.

The above was considered a minimum of the requirements for the Government to carry out its obligations. On April 1, 1898, Germany possessed, either built or building, 12 battleships, 8 coast-defence vessels, 10 large and 23 small cruisers, thus leaving to be built 7 battleships, 2 large and 5 small cruisers.

The strength of the fleet as contemplated by this law, known as the Sexennate law, has already been attained, and increase of the navy has again become of importance. This bill was supposed to be invested with something of definitive character, but already it has been found insufficient. The opening of the year 1900 was marked by the presentation of a new ship-building program of extended duration. This bill was passed by the Reichstag June 12, 1900. It is regarded as simply an increase in certain features over the Sexennate law. Its duration extends until 1916, but the period is not definitely fixed, and consideration of the bill would seem to indicate that it is proposed to build up the navy as fast as possible and as the financial condition, etc., may from time to time render most expedient.

The portion of the bill relating to the increase in number of ships is as follows:

1. The number of ships provided for under the law of April 10, 1898, concerning the German fleet, shall be *increased* by—

(a) Active fleet—

1 flagship (battleship).
2 squadrons of 8 battleships each.
2 large cruisers }
8 small cruisers } as scouts for the home battle fleet.*
5 large cruisers }
5 small cruisers } for service on foreign station.

(b) Reserve—

2 battleships.
1 large cruiser }
2 small cruisers } for foreign service.

and shall be decreased by two divisions of 4 coast-defence ships each.

2. In this increase, the 8 coast defence battleships shall be counted as line-of-battle ships until replaced.*

The bill as finally passed provides for 38 battleships, 14 large cruisers and 38 small cruisers. It also places the life of a small cruiser at 20 years instead of 15 years.

Germany's home battle fleet will then be composed of 34 battleships, 8 large cruisers, 24 small cruisers and 80 torpedo boats.

This increase in material necessitates a corresponding increase in personnel. This is provided for by a total increase at the end of twenty years of 33,551 officers and men. This total is to be attained by an annual increase of 89 officers and 1,687 men.

At present there is an unprecedented activity in the building of warships. During 1900, seven vessels have been launched, including two battleships, one large cruiser and four small cruisers. Six vessels are now in process of construction, including four battleships, one large cruiser and one gunboat.

The formidable nature of the proposed extension of Germany's naval force is evident. The German Government certainly takes a long look ahead, but strong arguments are presented for so comprehensive a program. "Germany requires peace on the sea." By having such a program defined by law, the prestige of Germany abroad is at once assured, and consequently such a policy is of the greatest importance to the political and commercial interests of the Empire.

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* The comparative inefficiency of the so-called coast defence ships of the *Siegfried* class, even in a moderate seaway, was confirmed in the German maneuvers of 1898. It was difficult for the ships of this class to work their guns in the rough sea and the Admiral dared not make an attack on the heavier and more seaworthy ships of the enemy,

Moreover, if there are 4 squadrons of first-class battleships, it will be less important to have a coast defence squadron, consisting of small ironclads.

ANDREW HERO, JR.,
1st Lieut. 5th Artillery.

THE SECOND BOER WAR.

VI.

THE THIRD CAMPAIGN AGAINST LOUIS BOTHA.

Lord Roberts moved his headquårters to Wonderfontein Station (25 miles east of Middelburg) on the 26th of August, preparatory to resuming the offensive against Botha.

Buller had moved out from Twyfelaar (near Carolina) in a northerly direction on the 23rd of August, French's cavalry clearing up his front and left flank. The latter met with considerable resistance, but the advance of Buller's division (especially the artillery) compelled the Boers to give way.

In this action (near Geluk) in consequence of a misunderstanding, two British companies advanced about 1500 yards into a hollow, out of sight of the main firing line, separated from the main body, and were surrounded by the Boers: they lost 1 officer and 12 men killed, 57 men killed and 33 prisoners.

On the 24th and 25th of August, Buller and French met with increased resistance, and it became evident that the Boers were preparing to make a stand in the hills west of Machadodorp. Pole-Carew had occupied Belfast on the 25th, and came in contact with the main Boer army at Dalmanthu. The British line extended from near Belfast back along the railroad some 30 miles, and the Boer front facing it was evidently strong and of considerable extent, and its artillery fire was well sustained. To form this line the Boer forces in the Bothas Berge, north-east of Middelburg, had to be considerably reduced, which explains the unopposed advance of Pole-Carew to Belfast, the Boer plan being to make an offensive advance with their left flank.

French, who had the duty of keeping up communication between Buller and Pole Carew, by the concentric advance of the latter necessarily came up with his cavalry between these two divisions, thus bringing the cavalry in the center of the front of operations. Measures were therefore taken to concentrate the British troops and at the same time get the cavalry on the flank again.

On August 26th the battle raged all along the line. Buller, with Littleton's division and two cavalry brigades, attempted to force his way north from the south-west of Dalmanthu, working around the Boer left flank. French took his two cavalry brigades behind Pole-Carew's division to the left flank.

The reasons for putting the cavalry division on the left flank were: to keep the Boers out of the malarious and difficult country of the Lydenburg district, and to force them along the railroad into the Portuguese colony.

French forced a part of the Boers towards Lenkenvley (on the Belfast-Lydenburg road, 5 miles north of Belfast), but the difficult country (hilly, broken and covered with dense brush) prevented his further advance and favored the Boer defence to such an extent that Pole-Carew had to move out in support. The advance met with stubborn resistance, the Boer positions being generally supported by guns of heavy caliber. But the Boer forces were not directed in such a way as to bring their tactics to bear with full effect, their resistance consisting in separate engagements, and was not based on any general plan. Consequently, in spite of the difficulties, the British made some headway, Buller forcing his way to Bergendal, while Pole Carew broke the Boer resistance at Lekenvley.

On the 27th, French, on the left flank, moved out over Lekenvley on the Lydenburg road as far as the Schwartzkopjes (10 miles north of Machadodorp), and then cleared up the ground in front of Pole-Carew's division.

The Battle of Bergendal.

Buller, however, met with strong resistance at Bergendal (between Belfast and Dalmanthu), a town lying at the foot of two kopjes commanding the approach, which led over an open plain, about a mile broad. The attack was conducted with excellent skill and judgment. Buller opened with a heavy artillery fire which was remarkably effective, utterly demoralizing the supports of the Boer front, and then advanced the Inniskilling Fusiliers, who took the town without a halt, and also occupied one of the neighboring hills, thus forcing the Boers to retire precipitately.

Buller lost 1 officer and 13 men killed, 7 officers and 57 men wounded; the Boers left 20 killed and 19 prisoners on the field. The Boers, retiring on Dalmanthu, disputed the advance foot by foot till dark.

Buller's advance on the 28th, however, met with little resistance, and before noon his advance guard reached Machadodorp. The Boers retired northward, pursued by Dundonald to Helvetia (7 miles north of Machadodorp) where the country became too difficult and dangerous far cavalry alone.

French advanced to Elandsfontein (9 miles west of Helvetia), establishing signal communication with Machadodorp. Pole-Carew followed French to the Zwart koppies (10 miles north of Machadodorp).

Presidents Krüger and Steyn fled to Nel Spruit, near the Portuguese border.

Buller continued his advance on Lydenburg on August 31st, over Helvetia, crossing the Crocodile River on the 1st of September, meeting with little resistance from Botha's rear guard. On the 2nd, however, he found the Boers (3000) in a strong position in the hills commanding Lydenburg.

French and Pole-Carew, having received orders to make a demonstration eastward, die not join Buller's column. An inversion thus resulted, the original right flank now becoming the left, due to the fact that Buller had started on the pursuit of Botha from Machadodorp, while Pole-Carew was still far to the rear, and French found the country too difficult for a large force of cavalry.

Buller reconnoitred Botha's position, and tried to turn its right flank, but found it too strong, and his artillery was unable to silence that of the Boers.

On September 3d, Roberts sent Hamilton from north of Belfast to reinforce Buller. Hamilton, whom Brocklehurst's cavalry brigade had joined, moved against the right flank of the Boer position, passing Dulstroom (27 miles south-west of Lydenburg) on the 4th, there coming in signal communication with Buller, who was at the time engaged in turning the Boer left flank.

This pressure on both flanks caused Botha to alter his position, withdrawing his right flank in a north-eastern direction towards the Mauch Berg, while a strong detachment on his left flank occupied the Spitzkop, 25 miles to the eastward of Lydenburg. By this change he avoided the outflanking movement against his left flank, and also withdrew his line out of reach of Hamilton's move against his right flank. Lydenburg was thus given up by the Boers, and was occupied on the 6th by Dundonald's cavalry (of Buller's division) and Brocklehurst's (of Hamilton's column).

Hamilton joined Buller on September 7th, and Buller prepared to attack the new position. A flank attack was impossible, consequently a frontal attack had to be resorted to, but as it was well supported by artillery fire, the British took the position with little loss.

The Boers had sent their artillery on to Krügers Post (about 25 miles north of Lydenburg), and fought a delaying action only, finally retreating northward, pursued by Buller over the Mauch Berg.

Hamilton was sent back to Machadodorp to take part in Pole-Carew's advance, while Botha, with about 3000 men, retired to Pietersburg, joining there Commandant Vorster.

Buller crossed the Mauchberg 10 miles east of Lydenburg on September 8th, entering very difficult country, and, driving the Boers before him, arrived at the junction of roads from east and south near Spitzkop on the 10th. He captured many wagons of food and ammunition, and divided the Boers, some retiring to Nel Spruit and others across the Sabie Drift. On the 12th he occupied Spitz Kop, and found there immense quantities of Boer supplies. He remained there till the 23rd, replenishing his supplies, and then moved towards Sabie Drift against Viljoen's force north of the river. He met with little resistance and advanced to Macmac River and Burgher's Pass. On October 2nd Buller returned to Lydenburg, after a circuitous march through the country from Spitz Kop *via* Pilgrim's Rest and Krüger's Post.

Meanwhile, Roberts continued his offensive advance eastward, with Pole-Carew and French, the former moving along the railroad, the latter covering his right flank; and later with Hamilton on the left flank. French reached Carolina on September 7th, and moved on Barberton, but met with considerable resistance before he reached the upper Buffels Spruit. However, he forced the Boers out of a number of consecutive positions.

At the same time the advance of Pole-Carew and French compelled the Presidents to leave Nel Spruit and retire on Komati Poort.

Krüger, leaving Schalk Burgher in charge of the government, left for Lorenzo Marques, on his way to Europe, to ask for foreign intercession. Steyn, taking command of all the Boer forces which retired eastward from Machadodorp, organized his forces for further resistance.

French occupied Barberton on September 13th, and made large captures, among them the great park of railroad rolling stock, including 43 locomotives. At the same time Pole-Carew occupied Kaapsche Hoop, to the north-west of Barberton. The further advance of the British to the Portuguese frontier was practically unopposed. On the 18th of September, 700 Boers crossed the border at Komati Poort and were disarmed; and a similar fate befell most of those who were forced over the Kaap Berge. But Viljoen, with a small force, succeeded in escaping northward, and marched over the hills of the Lydenburg district, to join Botha at Pietersburg.

Pole-Carew occupied the border station, Komati Poort, on September 24th, and made large captures of rolling material.

This ended the campaign, and practically ended all larger operations of the war.

GENERAL SITUATION.

On September 2nd, Lord Roberts announced the annexation of the Tranvaal. It is to be called, it is stated, the Vaal River Colony.

Raids against the railroads still took place in all parts of the two colonies, bridges were destroyed, and (due to carelessness in outpost duty) detachments were attacked and captured. Indeed, scarcely a day passed without some such incident.

A Boer commando under Erasmus, for example, made several energetic attacks on the British troops guarding the Pretoria-Pietersburg line, near Pretoria, in the month of September. South of Pretoria, portions of De Wet's and Theron's troops made attempts to destroy the waterworks of Johannesburg, and succeeded in liberating 500 prisoners from the jail at Klip River. Along the Ladysmith-Johannesburg road, especially near Standerton and Utrecht, small Boer detachments threatened road and trains continually. On the Johannesburg-Klerksdorp road, the Boers held Potchefstroom for a time. Even Methuen and Carrington, in the west, were kept constantly on the alert, and the little garrison town of Mamusa was surrounded by the Boers, and almost taken, before it could be relieved.

The most successful raids, however, were conducted in the Orange River Colony by Fouries, Grobler and Lemmer, later also by De Wet. A Boer force of 3000 suddenly appeared before Ladybrand and took it, but the approach of Hunter caused it to be evacuated again. At the beginning of September a Boer commando attacked Bruce Hamilton at Thaba 'Nchu, but was defeated.

The British were compelled to vacate Vrede, Bethlehem, Fouriesburg and Senekal, in order to concentrate their forces more effectually: Harrismith alone remained occupied.

In the vicinity of Kroonstad and even just south of Bloemfontein the railroad was occasionally destroyed.

On September 13th Macdonald at Wynberg heard of a Boer raid on the railroad at Brandfort, and immediately set out in pursuit, crossing to the south bank of the Vet River, near Tafel Kop. He came upon them eight miles west of that place, drove them over the the Vet River, and pursued them north of the Wynberg–Smaldeel Railway, utterly defeating them, and capturing a number of prisoners, wagons, oxen, ammunition and food supplies.

In spite of all these disturbances, however, the main military operations were ended.

Lord Roberts returned to Pretoria on September 22nd, and was appointed commander-in-chief of the British army, to succeed Lord Wolseley (retired), on October 1st. On October 16th General Buller relinquished command of the Natal forces, to return home; Lyttleton was left in command of his troops.

The resistance of the Boers, headed by Botha, Steyn and De Wet, continued throughout the month of October and into the next year.

During the first months Hildyard operated in the south-eastern Transvaal, Clery in the vicinity of Standerton, Clements in central Transvaal, near Rustenburg and Krugersdorp, Hart south-west of Krugersdorp, Methuen in western Transvaal, while Paget and Plumer held the northern posts. Rundle was in the vicinity of Bethlehem, Knox at Kroonstad, Barton near Krügersdorp, Bradley near Heidelberg, Hunter near Mequathing's Nek, Macdonald near Winburg and Senekal, Brabant at Heilbron and Lindley, Kelly-Kenny at Bloemfontein.

Guerilla warfare continued at all these points, and detachments up to a strength of 1500 or 2000 occasionally assembled, although most of the raids were made by much smaller bodies.

One of the latest and most important of the combats with the Boer raiders was that of Bothaville (north-west of Kroonstad, south of Klerksdorp), where Colonel Le Gallais met a Boer force of 1000 men (among them Steyn and De Wet) and completely defeated them. He captured six field guns, two machine guns, and 100 prisoners, the Boers leaving 25 dead and 30 wounded on the field. The British lost 3 officers and 8 men killed, 7 officers and 26 men wounded.

This Guerilla warfare gradually subsided towards the end of January, and the war virtually ended. Great Britain added two extensive colonies, rich in gold, diamonds and cattle, to her domains, and sustained a total loss in officers and men of about 12,800.

COMMENTS.

At the opening of the fifth act in this war drama the main Boer army in the west was at Middelburg and Hatherley, east of Pretoria, and the question for Lord Roberts to decide was, whether he should attack this army and disperse it, or send a strong detachment by rail to Volksrust, to assist Buller in his attempts to turn the Boer position at Laings Nek, and hasten the retreat of Christian Botha northward. After the performance of both these tasks he would be prepared to begin operations against the Boer troops waging a guerilla war in the Lydenburg district, where the latter were strongly ensconsed in the mountains, and well provided with supplies from Lorenzo Marques.

The effect of Roberts' advance to Pretoria undoubtedly made itself felt on the resistance of the Boers at Laings Nek, but Buller deserves great credit for the masterly way in which he maneuvered the latter out of their extremely strong position with little loss, and succeeded in cutting them in two.

Tactically, however, he failed to reap the full reward of his strategical measures, since the Boers escaped without loss in men or material. This may have been due to the fact that, having learned the futility of purely frontal attacks, he went to the other extreme, and laid too much stress on outflanking movements, which are never very successful tactically, unless the frontal attack is pressed hard at the same time, in order to hold the enemy while the flanking columns roll them up.

Buller's movement had another great advantage in that it separated the Transvaal from the Orange Boers, occupying the Drakensberge and assembling to the south-west under President Steyn, and prevented the former from joining the latter. Had he turned their position by the east (his first plan) the strategic situation would have been far less advantageous.

It would appear at first sight that Buller's proper course after reaching Volksrust was to hasten northward to join Roberts in a combined attack on the Boers near Middelburg. But the reconnoissances from Roberts' army had determined the position of the latter, under Louis Botha, east of Pretoria, to be in a strong, although very extended line. Moreover, although Pretoria and Johannesburg were perfectly quiet, he feared the effect of such close proximity of a strong Boer army, and decided to attack it without awaiting the arrival either of Buller or Hunter.

Roberts' prompt decision to attack the center of Botha's position, as soon as he found it impracticable to turn the flanks according to his previous tactics, thus far uniformly successful, marks the *general,* ready at all times to suit his methods of warfare to the existing circumstances. His failure to pursue, however, after the battle, and determine definitely the whereabouts of the enemy, is open to criticism.

His comparatively small force, the danger threatening his line of communications, and the ravages of disease in the army (which were great in the months of May and June), no doubt determined him to risk no further engagement with Botha, but this does not excuse the neglect of reconnoissance of the enemy during the retreat of the latter.

The splendid strategic campaign of Lord Roberts ended, the weaknesses of the British army in their neglect of proper reconnoissance and the service of security and information once more come into prominence. To subdue the scattered forces of the Boers it became necessary to subdivide the army, thus throwing the responsibility for the minor tactical operations on the subordinate commanders; consequently surprises and captures of detachments became almost daily events. No doubt much of the neglect of outpost duty was due to the poor state of the cavalry horses, but most of the failure must be ascribed to the lack of proper training of the troops in such service.

Buller, after entering the Transvaal, had two courses open to him: on the one hand, he could have operated against the Boers retreating on Ermelo, and seized the Lorenzo Marques railway, cutting off Botha from his source of supply at the latter point, and thus ending the campaign in this region; on the other hand, he could move along the railway line to Johannesburg and complete the cordon around the Orange Boers, at the same time opening a new line of supply for Roberts' army.

The first plan would have compelled him to leave the railroad and organize a large train, which was well-nigh impracticable. Roberts, therefore, decided on the second plan, which would also bring Buller's force in contact with his own.

Turning now to the campaign against De Wet near Bethlehem, we find again one of the deficiencies of the British officer coming into prominence, viz: the lack of proper service of security and information. The entire strategic plan of Roberts,—the concentric advance on De Wet's position—was virtually defeated by the want of definite information of the exact position of the latter, the slow advance of Hunter, the too dispersed order of march of Rundle and finally the precipitate dash of Paget, who became involved in a position where he had to await reinforcements, and changed the proposed concentric advance into a mere forward movement of a single body.

Again, after Rundle discovered the Boers in strong force east of Rooikrans, which should have indicated to him that De Wet had selected this point for breaking through, he made no special arrangements to resist his efforts, and allowed him to escape with ease, preserving his too extended order of advance even after the motives of De Wet were evident.

The capture of Prinsloo's force, on the other hand, was effected with skill and judgment.

It is a question, however, if De Wet would not have been wiser to have broken through to the eastward, over the Drakensberg passes and joined the remains of the Boer army north-east of Laings Nek.

The surprise of the British garrison at Rustenburg by Lemmer must be ascribed once more to imperfect outpost service; and to this same weakness of the British troops the surprises at Uitvals Nek and Derdepoort must be attributed.

Campaign of Middelburg.

In the organization and execution of the advance, four points at once strike the military student, viz: *first,* the placing of Hamilton's mounted infantry on the left, and French's much more mobile cavalry division on the right; *secondly,* the broad front of the advance, and the distance of the flanking columns from the main column; *thirdly,* the small force which Roberts selected for this service; *fourthly,* why Buller was allowed to remain practically inactive, when he might have brought fatal pressure to bear on the Boer left and rear.

In the first place, Hamilton's troops had to go a longer distance to reach the left flank than they would have had to take the right; and in the next place, both were familiar with the country (from their first advance against Eerste Fabriken) on the opposite flanks from those now assigned to them. Moreover, as Roberts' plan evidently involved preventing the Boers from retiring into the hills of the Lydenburg District, French's advance north of the railroad would have been far more in place. His flanking movements south of the railroad merely forced the Boers back on their line of retreat.

The broad front of Roberts' advance, and the far outflanking movements of French, prevented concerted action of the various parts on account of the distances to be covered. On this account, after French's scouts crossed Olifants River, and found the Boers in full retreat, it was impossible for Roberts to take advantage of the situation, because the center and left was still far in rear. A flanking movement can only be successful when the flank column reaches the enemy in good condition, and can count on the assistance of the rest of the army.

The force assigned to this service by Roberts had a strength of about 22,000 men, and was destined to attack a skilful enemy, well intrenched in positions of his own selection, about 12,000 strong. Decisive results could hardly be expected under such circumstances, and when Pole-Carew and French, with 15,000, were left alone to continue the pursuit, it is not surprising that they did not go beyond Middelburg.

Buller's advance against Middelburg would have protected the northern side of the railroad much better than quietly guarding it, and would have threatened the Boers in front of Roberts besides. Moreover, at that time there was little danger of Boer raids south of the railroad.

After it was found that Pole-Carew and French could not advance with safety beyond Middelburg, then at last was done what should have been done when the advance against Middelburg began, viz: Buller was directed against the Boer left flank and rear.

The Chase of De Wet.

One of the first points that strikes the military student in this pursuit of De Wet is the fact that the separate British columns acted perfectly independently, with no single controlling power to direct the movements on the field intelligently towards the common end. Kitchener and Methuen were independent, and when they struck De Wet neither knew the exact situation.

Smith-Dorrien, when he tried to block De Wet's way near Welverdiend, had only troops which had been worn out by constant marching too and fro, due to conflicting orders, and the lack of a directing head, and so failed to stop the Boer leader.

And finally, Paget and Baden-Powell, by getting themselves involved in combats with small detachments at a critical moment, allowed De Wet to escape when he was practically surrounded: again the independence of the individual leader caused the failure of the strategic measures.

Another point that strikes the military student is the fact that the British failed to distinguish between the important or essential, and the unimportant, or trivial. When Roberts had carried his campaign against the main Boer army, under Louis Botha, nearly to Middelburg, he returned with the mounted infantry of Hamilton and Mahon, giving up a serious campaign at a critical moment, to secure a subordinate (unessential) object, viz: the line to Mafeking, where he had 15,000 troops already posted in western Transvaal. Again, Methuen was taken away from this line to act against a paltry 1500 under De Wet. Finally, Hamilton, after being sent to the relief of Rustenburg, the object of which was evidently to secure the line to Mafeking, brought Baden-Powell away from that point and left him at Kommando Nek, and himself joined in the pursuit of De Wet.

The last prominent characteristic of these movements is the fact that some of the British subordinate commanders did not prove equal to the tactical and strategical situation, and that they failed in intelligent, combined action. Carrington's decision, after having been ordered to relieve Hore, to retire not only to Zeerust, but even farther, does not seem warrented by the circumstances, and more concerted action by the other subordinate commanders should have brought better results.

The Third Campaign against Botha.

The third campaign against Botha, beyond Middelburg, was conducted in Roberts' true manner, and his measures substantiate our views on the second campaign in two leading particulars, viz: the fact that the place for the cavalry was on the left, and the necessity for Buller's advance in flank at the same time. Nevertheless, the transfer of the cavalry to the left flank at so late a stage failed to prevent Louis Botha from escaping into the Lydenburg district, as it would have done had it been on that flank originally; moreover, Buller's participation came too late for *decisive* effect in capturing the Boers, or in forcing them to fight a decisive action.

The latter part of this campaign was a splendid achievement, and illustrates the effect of properly applying a sufficient number of troops to a definite purpose, and pursuing this purpose with single-minded determination to the end.

The Boers, on the other hand, had split up their forces, scattered them over a wide area, had no concerted action under single leadership, and failed to concentrate for any definite purpose: consequently their resistance was rapidly destroyed.

TACTICAL DEDUCTIONS FROM THE WAR.*

In drawing lessons from the war in South Africa the first point to be taken into consideration is the general character of the armies opposed to each other. On the one hand, there is a crude militia, insufficiently organized and trained in time of piece, but composed of exellent, though undisciplined, material, untrained in tactics, hence incapable of the tactical *offensive*, so indispensable for decisive results. On the other hand, a European army, composed of a large nucleus of regular troops, disciplined and trained, but its greater part militia and volunteers of variable quality, generally only partially trained, with all the technical and scientific means of carrying on war at its disposal.

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* The author is indebted for much of his information and many of his ideas to an anonymous article in *Internationale Revue*, Beiheft 14; and to the *United Service Magazine*.

Fire effect serves as a basis for all tactical deductions. The Lee-Metford and the Mauser gun, in spite of certain advantages of the latter over the former, must be regarded as practically equal in the field. But the possession of a bayonet gave the British a decided advantage over the Boers (who were without one), not because hand to hand conflicts are liable to be very common in modern war, but because the moral effect of its possession confers tenacity on the defense and confidence and *esprit* on the attack.

As marksmen the Boers had the advantage, for they were all trained to this accomplishment from their youth, and kept up their practice by their mode of life. They surpassed probably, in this respect, all European armies.

The Artillery Arm.

The field artillery material used by the two armies is an interesting study, but in judging of the relative degree of preparedness, the circumstance must be carefully considered. The Transvaal had been arming since 1896, purchasing the best material procurable, and it so happened that at this time the field artillery of Europe was in a transition stage, but on the continent rearmament had commenced, consequently the Boers had their choice of the latest designs. England, however, had been slow to adopt the changes effected on the continent, and had merely modified its existing carriages, while the guns remained the same. The result was that the Boers were possessed of the latest quick-firers, with fixed ammunition, and the ranges exeeded that of the British field gun by several thousand yards.

Small as these differences were, they soon proved great in effect, because it was this little difference that enabled the Boers with single guns to put a number of shell into a British battery before the latter could reply, and the only reason they failed to accomplish more than they did, was because they had but a small number of guns and did not know the value of concentrating their fire; moreover, they were afraid to risk a stand-up fight.

It has been urged that field guns are not intended to engage siege guns; but the British guns frequently failed to reach even the Boer field guns when the latter could reach them. The 5-inch field howitzer had a range of only 4900 yards, and frequently failed to be of use on that account. At Venters Spruit something might have been done to assist the British troops on top of Spion

Kop if only their guns had had a little longer range: some forty British guns were forced to remain idle, while a few Boer guns shelled the crest of the hill. In the demonstration against Brakfontein heights, preceeding the attack on the Vaal Kranz, six field batteries were so effectually outranged that they had to stand still, to be shot at; and a few days later the single Boer gun on the Doornkloof defied all the British guns in the plain or on the Schwartz Kop. In this last case a howitzer of sufficient range was all that was needed.

That it is possible to combine in the field gun increased range with mobility is proven by the fact that the Boers accomplished it, and that Captain Scott constructed temporary carriages for the 12-pdr. guns of the Naval Brigade, which weighed (with gun, complete) approximately only two-thirds as much as the field equipment, while the guns were sighted up to 8000 yards, and could be fired at even greater ranges.

The other advantages of long range in field pieces are that the enemy's advancing infantry can be brought under shell fire earlier, or a larger extent of front of his defensive position can be swept by the artillery without changing position; moreover, the artillery can be kept farther in rear and still be effective, a great advantage under modern infantry fire. On the contrary, short range field guns can only come up behind infantry, and must be correspondingly slow in getting up.

In view of this great importance of range, it is evidently better to sacrifice some degree of mobility, if it be necessary to sacrifice anything, in order to secure a good heavy long-range field gun, provided only it can keep up with the infantry.

The effects of earthworks and their extensive use have merely substantiated what was predicted by the best authorities. They have demonstrated the necessity for a howitzer to search trenches, since ordinary field guns can only serve, by a constant storm of shell, to keep the enemy in them, but cannot reach him there.

The advantage of quick-firing guns was illustrated at Brakfontein, on February 5th, where *three* Boer guns easily maintained a rate of fire and a storm of shell on six British field batteries (unable to reply because outranged) such as a battery of *six* British guns could not have produced by using its most rapid rate of fire. Another advantage of quick-firing guns is that the number of guns to a battery can be reduced to four, and hence the target presented by a battery be made much smaller, and cover can be more easily secured. Quick-fire guns also offer the great advantage of quickly engaging a moving target and following it up readily: at Brakfontain the slow rate of fire of the British and their system of fire discipline allowed a Boer gun to retire and a pom-pom to be brought into action before a shot from a field gun could be fired.

The experiences in South Africa seem to point to the following as the proper equipment of an army as regards artillery:

1. A quick-fire gun, perhaps a little more mobile than the present field gun, capable of accompanying *mounted* troops on the march.

2. A heavier gun (including the howitzer) of long range, capable of moving with *infantry*.

3. A light mountain gun in country where only pack-animal transportation is to be had.

The small actual effect of the pom-poms of the Boers, in spite of their great moral effect and their mobility (which enabled them to follow readily in pursuit), confirmed previous experience. Their high rate of fire (10 shots a minute) could not make up for the low weight of projectile, and the consequent limited action in depth of troops struck. The campaign shows that the use of guns of smaller caliber than 75 mm. is only permissible in mountain or barbarian warfare, or against torpedo boats.

The Physiological Effects of the Infantry Arm.

All authorities agree that the wounds from the small-arm bullets are more humane than those from the old large caliber projectiles. According to the eniment English surgeon, Sir William MacCormac, the human body can in many cases be perforated by the bullets without fatal results. About 96 percent of the wounded at the base of operations in South Africa recovered, and a large percentage returned to the front. Most of the wounds leave a very small opening at the points of entrance and of exit. Most of them stop bleeding themselves, and heal very rapidly. Prens, in the *British Medical Journal*, asserts that at ranges of from 1500 to 2000 to Mauser bullet goes through bones like a needle, and only at close ranges (up to 500 yards) does it shatter the larger bones, while breast wounds heal readily. Amputations are rarely necessary.

Losses in Battle.

One of the most interesting features connected with improvements in fire-arms is the fact that the losses in battle constantly grow smaller. The following table will illustrate this:

	Percentage of killed and wounded.	Percentage of the killed in the total losses.	
		Offensive.	*Defensive.*
Wars of Frederich the Great	15	19	25
" Napoleon	13	10	21
Crimean War	12	17	29
Campaign of 1859	8	9	19
Campaign of 1866	8	9	24
Campaign of 1870-1	9	9	24
Battle of Ladysmith (10,000 British)	3		
" Stormberg (2,500 ")	3.6		
" Magersfontein (10,000 British)	9		
" Colenso (17,000 British)	5.3		
" Spionkop (20,000 British)	7		

The percentage of losses in officers is remarkably high. At Magersfontein, for example, it reached 25 percent, or one officer for every 14 men killed, wounded and missing.

Relation between losses in battle and losses by disease.

As a general rule, losses by disease in long-continued wars far exceed losses in battle: the only known exception is the Franco-Prussian War of 1870-1. Another fact worth noticing is that the losses in battle grow smaller as war progresses, while those from disease grow greater, and the latter in a higher ratio for the men than for the officers.

The British losses at short intervals are given in the Appendix, but the number of sick is not clearly stated in the official reports.

The following table gives some idea of the relative mumbers of those who were killed (or mortally wounded) in battle and those who died of disease (or accidents) at various intervals:

	Killed.		*Died of Disease.*	
	Officers.	Men.	Officers.	Men.
Up to February 24	198	1748	20	722
" May 26	285	2672	95	3127
" July 30	324	3013	126	4270
" September 8	368	3462	152	5573
" October 21	391	3795	162	6350

Transportation of Horses by Sea.

Between the 30th of September and the 24th of March about 24,333 horses were transported on some 70 vessels, with a loss of 5.5 percent., not considering the *Ismore*, which stranded with 315 horses on board, and the *Rapidan*, which did not proceed farther than the Irish Sea. In some cases the percentage was very low: in 9 ships, for example, it ranged between ½ and 2 percent. In others, on the contrary, it ran very high: on the *America*, for example, as high as 24.3 percent.

Lessons for the Defense.

The operations of the Boers illustrate fully whatever advantages attach to the strategical defensive. The reasons for their adopting this form were probably three: the peculiar characteristics and nature of the Boer, his lack of military obedience and discipline, and the difficulty of replacing losses in battle by new levies.

In Natal they combined the strategical offensive with the tactical defensive, and, as ever, they were defeated in the end.

Their *positions* were always well selected, and intrenchments in two tiers (one over the other) were very common. Fire was first opened from the upper tier, that of the lower being reserved for close quarters. The Boers also constructed dummy intrenchments, from which they fired with smoky powder. Perfect use of the configuration of the ground was generally made, and at Paardeberg a special form of trench widened at bottom (as shown elsewhere in the text) was made use of in the firm ground found there.

Wire entanglements were placed in front of positions, which not only delayed the attack, but also enabled the Boers to guard the ground in front with weak detachments, the noise of passing through the obstacle giving sufficient warning. Such was the case at Magersfontein, for example.

The occupation of *advanced positions* (in front of the general line) by the Boers is contrary to the accepted ideas of tacticians. But their success in the war was due to the fact that the British generally resorted to purely frontal attacks, and thus enabled the Boers to make the very best use of them. Moreover, the Boers were usually mounted, and their horses (owing to the terrain) could be kept close at hand, so that, when it came to the short ranges, they could quickly retire.

The question of *when to open infantry fire* is comparatively simple for the attack, as it is determined by the fire-action of the enemy's arm, the object being to get as near as possible to the inner limit of the medium battle ranges before opening fire. But for the defense the problem is more difficult, because the opening of fire at once discovers to the enemy our positions, and offers targets for their artillery. Most European nations would now open fire at about 1000 yards, to prevent the enemy from ever reaching the close range (600 yards) at which the defender's heads begin to be visible targets.

But the Boers wisely did otherwise, and allowed the enemy to come to close range before opening on him. This action is entirely justified because of the great superiority of the British in artillery, because at close ranges the latter can no longer take part. Moreover, the moral effect of a sudden, overwhelming infantry fire is enormous even on the best of troops, and in South Africa the withholding of the fire was particularly justified because the British often approached close to the Boer positions in closed masses, and in utter ignorance of the exact position of the enemy. Examples of these points will be found in the battles of Modder River, Magersfontein and Stormberg. In the first the losses of the subdivisions in front were considerable; in the second the actual losses were slight, but the demoralized battalions could not be assembled again until the following day; and in the last the losses in killed and wounded were only 3½ pct., but in prisoners it amounted to 25.3 percent.

These examples illustrate the necessity of accurately locating the enemy's subdivisions in his position, and determining that position from a distance.

Whenever the Boers did open fire at longer ranges the British advance was generally stopped at 900 yards.

Lessons for the Attack.

The British mode of *attack* is characterized, at the opening of campaign, by its purely frontal form, and by the insufficient numbers placed on the line; by taking up the formation for attack at too late an hour; and by laying too little stress on gaining superiority of fire.

At Magersfontein, for example, the artillery opened fire on the Boer position, while the infantry remained in rear and gave no assistance. The result was that the Boers lay quietly in their trenches. The infantry of the attack must move up and support the artillery fire by its fire action, in order to compel the enemy to occupy his positions and thus offer targets for the artillery. The two arms must work together: artillery and infantry preparation for attack are not two successive phases of a battle, but must be simultaneous.

Night marches and *night battles* found considerable application in this war. On the Tugela, at Spion Kop, at Stormberg and at Magersfontein examples are found. In several of these cases the great objection to night marches, namely the danger of a panic, is decidedly in evidence. The only remedy, acknowledging the necessity for such operations, is for the officers to use all their power to prevent a panic, or to keep it in bounds. The great trouble with the British in these night attacks was the fact that they advanced without outposts: this may be risked by a single company but never by a column of all arms, 2000 strong.

The examples prove that night battles on a large scale are impossible. The taking of the Spion Kop at night was a proper measure, as also would be an approach by night over open ground to an enemy's position, but all these require careful previous reconnoissance of the ground to be passed over. Moreover, the men should be fully impressed with the idea that night fire is not dangerous, and as soon as the enemy opens it all the troops must charge with all their energy.

These are a few of the lessons to be learned from the Boer War, but perhaps the most impressive lesson of all is the high significance, true for all time to come, of the tactical and strategical *offensive*.

APPENDIX.

Total British Casualties to August 25.

	Officers.	Men.
Killed	281	2,599
Died of wounds	79	732
Died in captivity	1	85
Died of disease	148	5,215
Died of accidents	1	90
Sent home as invalids	1188	27,309
Missing and prisoners*	55	2,778
Total†	40,561	

Total British Casualties to September 1.

	Officers.	Men.
Killed	283	2,655
Died of wounds	83	758
Died in captivity	1	85
Died of disease	148	5,332
Died of accidents	3	95
Sent home as invalids	1213	27,937
Missing and prisoners*	45	1,007
Total†	39,645	

Total British Casualties to September 8.

	Officers.	Men.
Killed	283	2,683
Died of wounds	85	791
Died in captivity	3	86
Died of disease	149	5,472
Died of accidents	3	101
Sent home as invalids	1219	27,937
Missing and prisoners*	40	945
Total†	39,785	

Total British Casualties to September 17.

	Officers.	Men.
Killed	285	2,718
Died of wounds	86	797
Died in captivity	3	86
Died of disease	149	5,582
Died of accidents	3	107
Sent home as invalids	1239	28,199
Missing and prisoners*	12	809
Total†	40,075	

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* Excluding those who have been recovered.

† Excluding sick and wounded now in British hospitals in South Africa.

Total British Casualties to September 22.

	Officers.	Men.
Killed	287	2,738
Died of wounds	86	813
Died of disease	149	5,653
Died of accidents	3	108
Died in captivity	3	88
Sent home as invalids	1279	29,957
Missing and prisoners*	9	799
Total†	41,972‡	

Total Reduction of British Forces Through the War.

	Officers.	Men.
Deaths in South Africa	528	9,400
Missing and prisoners	9	799
Invalids who died in England	4	183
Invalids discharged for disability	....	814
Total	11,737‡	

Total British Casualties to September 29.

	Officers.	Men.
Killed	287	2,750
Died of wounds	86	825
Died of disease	150	5,753
Died of accidents	3	114
Died in captivity	3	89
Sent home as invalids	1326	30,300
Missing and prisoners*	7	812
Total†	42,505‡	

Total Reduction of British Forces Through the War.

	Officers.	Men.
Deaths in South Africa	529	9,531
Missing and prisoners	7	812
Invalids who died in England	4	193
Invalids discharged for disability	....	873
Total	11,919‡	

Total British Casualties to October 31.

	Officers.	Men.
Killed	302	2,902
Died of wounds	89	893
Died of disease	155	6,115
Died of accidents	4	145
Died in captivity	3	90
Sent home as invalids	1422	33,077
Missing and prisoners*	7	822
Total†	46,026‡	

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* Excluding those who have been recovered.

† Excluding those in South African hospitals.

‡ The great majority of those invalided home had recovered and rejoined.

Total Reduction of British Forces Through the War.

	Officers.	Men.
Deaths in South Africa	553	10,145
Missing and prisoners	7	822
Invalids who died in England	4	208
Invalids discharged for disability	....	1,030
Total*	12,769†	

OFFICIAL TABLE OF CASUALTIES.

(PRINCIPAL ACTIONS ONLY.)

	Killed.		*Wounded.*		*Missing.*	
	Officers.	*Men.*	*Officers.*	*Men.*	*Officers.*	*Men.*
Sunday River. April 10		1		14		1
Wepener. April 9–18	6	17	17	105		
Zwartkopjesfontein. April 19–20		3		16		26
Dewetsdorp. April 20			1	9		
Wepener. April 17–24		8		36		
Wakkerstroom. April 21, 25			3	19		
Karrefontein. April 22		3	2	26		3
Grootefontein. April 24		3		35		
Thaba 'Nchu. April 28–30		3	3	46		13
Gen. Ian Hamilton's force. April 30	1	3	10	6	1	9
Jacobsrust. April 30–May 3		5	2	35		10
Brandfort. May 2–5		3		48		8
Wellow. May 4	2		1	6		
Boordam. May 4		8	2	35		1
Kroonstad. May 10–11		3	1	37		3
Wepener. May 10	3	27	14	109		1
Zand River. May 10	1	15	5	31		1
Maritsani. May 13		5	1	22		3
Vryheid (ambuscade). May 20	3		2			1
Winburg. May 25–6		3		16	1	1
Kheis. May 28	1	4	5	17		
Roodepoort. May 28		1	2	31		
Hammonia. May 28–29		3	1	4	2	38
Senekal. May 29	1	41	11	129		11
Florida. May 26	1	19	11	112		
Douglas. May 30		18	2	36		
Lindley. June 1	1	18	9	43		13
Bothas Pass. June 6–8		8	2	34		
Swalkranz. June 4					1	53
Roodeval. June 7		6	1	21		4
Heilbron. June 7		2	1	2	1	6
Vredefort. June 7					1	17
Roodeval. June 11		1	1	17		
Diamond Hill. June 11	6	6	10	119	1	3
Almonds Nek. June 11		17		116		
Diamond Hill. June 13	1	21	1	81	2	
Leuwspruit. June 14		1	4	4		60
Vredefort. June 17			1	18		11
Rhenoster. June 17		1		3	2	51
Honingspruit. June 22	1	4	2	18		
Amersfoot. June 29		2		7		

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* Excluding those in South African hospitals

† The great majority of those invalided home had recovered and rejoined.

	Killed.		*Wounded.*		*Missing.*	
	Officers.	*Men.*	*Officers.*	*Men.*	*Officers.*	*Men.*
Machadodorp. July 3						25
Lindley. July 3	1	2	3	10		8
Reitzfontein. July 7	2	4	1	28		
Bethlehem. July 6–8		10	6	111		
Rustenburg. July 7		2	1	4		
Derdepoort. July 11	1	2	2	5		18
Uitvals Nek. July 11	1	16	3	50		183
Krugersdorp. July 11	1		2	33		
Reit Vlei. July 16	2	5	2	27		6
Potchefstroom. July 19–22				3		23
Bank (captured in derailed train). July 19						31
Palmeitfontein. July 19		4	4	18		3
Oliphants Nek. July 20		2	1	5		
Koster River. July 21		5	6	20		6
Spitz Kop. July 21–22		4	2	20		
Stafferts Nek. July 23	1	8	3	28		
Retiefs Nek. July 23–24		9	6	77		
Rooi Koppies. July 24		2	1	21		
Stinkhoutboom. July 24		4	8	24		
Slaapkrans. July 28		3	3	27		
Stepannskral. July 29	1		1	21		
Frederikstad R. R. accident. July 30		18	1	43		
Zelekats Nek. August 1		2	2	41		
Elands River. August 4–6	1	4	1	32	1	9
Elands River (Carrington's force). August 4–6	1	2	1	10		1
Amersfoort. August 7				22		
Venterskroom. August 7		1	6	13		
Greylingstad. August 13–14		2		5		8
Wilport. August 14		4	1	41		
Buffels Hoek. August 19				6		9
Klipfontein. August 19					5	21
Hamans Kraal. August 20	1	1	1	11		
Van Wyks. August 21		7	2	22		5
Geluk. August 23–26		19	2	97	2	51
Belfast. August 24–26		3	2	45		3
Doomoek. August 26			1	10		6
Bergendal. August 29	1	12	9	95		
Jachtfontein. August 29		1	1	6		1
Kwaggasfontein. August 31		5	6	11		2
Badfontein. September 1–4			1	17		7
Mauchberg. September 9			1	6		
Lydenburg. September 4–10		3		34		2
Rochfontein. September 11		2	1	14		
Ventersburg. October 10	1			11		
Jagersfontein. October 13–16		11	1	13		
Carolina October 13–14		6		21		
Carolina to Bethel. October 15–19	1	5	3	21		3
Frederickstad. October 19–25	1	22	4	89		3
Jacobsdal. October 25		11		16		
Bethlehem. October 26		3	1	16		
12 miles south of Belfast. November 2	1	1	2	12		1
Bothaville. November 6	2	6	7	24		

Captain John P. Wisser, 7th Artillery.

* * *

THE DEVELOPMENT OF THE KRUPP FIELD ARTILLERY MATERIAL.*

(Translated from the German by M. WILLIAMS, and arranged for publication in the office of the Chief of Ordnance.)

(Continued.)

III.

After numerous and extended trials of the several models, Krupp's factory has adopted for field guns the system of revolving top carriages and the pivot fork. (See fig. 19).

To protect the traversing mechanism during transportation the top carriage is bolted to the under carriage.

IMPROVEMENT OF THE BODY OF THE CARRIAGE.

Krupp's factory has succeeded in pressing the top carriage and lower carriage out of one plate each, whereby the flasks are bound together on the underside, giving the appearance of a trough. The underside uniting plate replaces the transoms, which are omitted altogether, and with them the numerous rivet holes. This facilitates the construction of the carriage and enhances its power of resistance.

SHIELDS.

The application of shields to rapid-fire guns has been much recommended. The object of these shields is to protect the cannoneers, especially the gunner, against shrapnel and small arms bullets, thereby encouraging a more quiet and more exact aiming. Although Krupp's factory, in deference to the wishes of some purchasers, has made many field guns with such shields, and possesses an excellent material for building them, in its special steel, which, with a thickness of 5 mm. (.197 inch)—that is, a weight of 38 kg. per square meter (7.77 pounds per square foot)—has withstood the fire of steel-jacketed bullets of the most modern small caliber guns, still it does not recommend the shields. The main drawback is that they increase the weight of the piece by their own weight and that of their fittings. This extra weight of covering could better be applied to the gun for greater effectiveness. If the shields are not made too big—that is, not weighing over 60 kg. (132 pounds)—they can, under the most favorable circumstances, only protect two men from the head to the knees, and two more men partially, and always against front fire only. All the other gunners remain unprotected. The shield also betrays the position of the piece, and thus the artificial cover takes from the gun part of the natural protection afforded by the difficulty of locating it from a distance. If the gunners are hit by shot falling near the gun, or if the shield is pierced by pieces of shells, the existence of the shields can have only an unfavorable effect on the men, rather detracting from their confidence in the weapon than adding to it.

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* Reprinted by permission of the Chief of Ordnance, U. S. Army, who also very kindly loaned us most of the plates.—ED.

THE CARRIAGE AS PART OF THE GUN VEHICLE.

The fact that the strain on the system as a vehicle in the long run is greater than that as a firing structure has already been mentioned, as has also the importance of a low line of fire for the gun. When purchasers do not give special orders, Krupp's carriages have a gauge of 1.5 m. (59.1 inches) and a diameter of wheel of about 1.35 m. (53.2 inches). Neither of these is a hard and fast rule, and much depends on the center of gravity of the whole system. Narrow gauges become more unfavorable the higher the center of gravity lies ; this is especially noticeable in sharp turns at a rapid pace, because the wheels of the limber are liable to strike the flasks and the limber be overturned.

This occurs more frequently the higher the wheels are and the shorter the angle of turning.

WHEELS.

The extraordinarily heavy and irregular strain on the wheels during firing and in transportation, and also the difference of climate of countries whither Krupp's factory sends its material of warfare, render very difficult the building of carriage wheels good under all conditions. The present model of Krupp's field-gun wheels is the same as was formerly used in high-angle fire guns only and which is well known from descriptions and sketches. (See the Krupp 12-cm. field howitzer). The special peculiarities of these wheels are steel tires, ribbed-steel hubs, fellies of bent wood cut with the grain, use of steel spoke shoes, to connect the spokes with the inside surface of the fellies. Krupp's factory has used these spoke shoes since the beginning of 1887. Such a wheel is shown in fig. 22, page 177.

The substitution of metal for the wooden parts, especially the spokes, has not become feasible without increasing the weight and the difficulties of renewing the parts. The experiments of the factory were made partly with wheels with tube-shaped spokes, partly with wire spokes (Imperial German Patent 66,987 of June 14, 1892). In both cases the said drawbacks appeared.

It is also known that the iron wheels used in England and France on some guns are very heavy, and the experience derived therefrom is not encouraging. The factory, therefore, continues to use wooden wheels.

AXLES.

The endeavor to lower the height of firing led in most carriages to carrying the axle through the flasks, instead of securing it under the carriage, as was done formerly. The center of gravity in the new carriages consequently lies lower, that is, more favorably, and the whole construction gains in stability. Under special circumstances, hollow axles can be employed to advantage. A smaller inclination of axle arm and a smaller dish of the wheel have proved most satisfactory, both as regards the journals and the spokes.

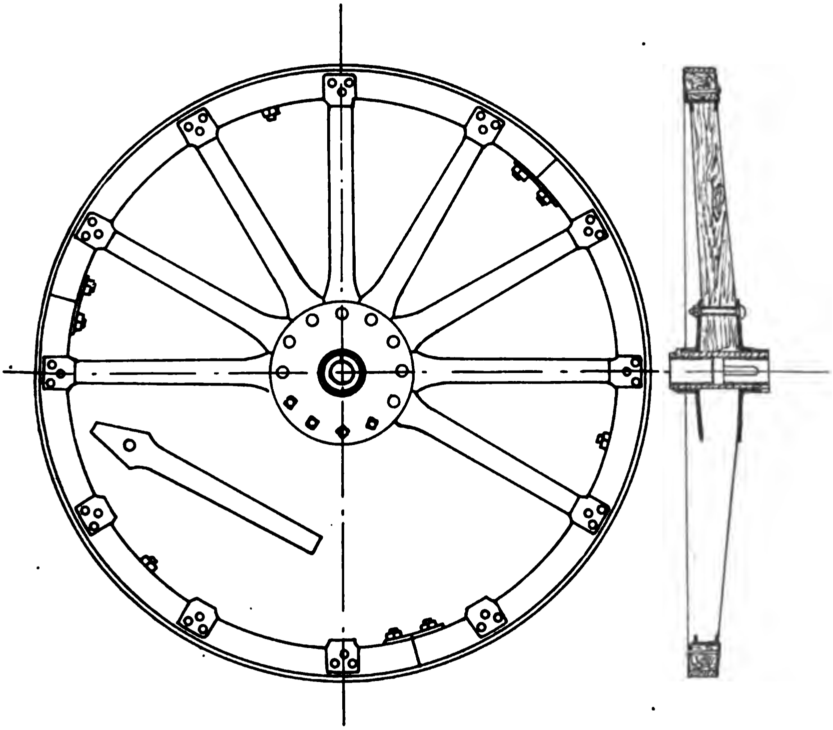


Fig. 22.

ROAD BRAKES.

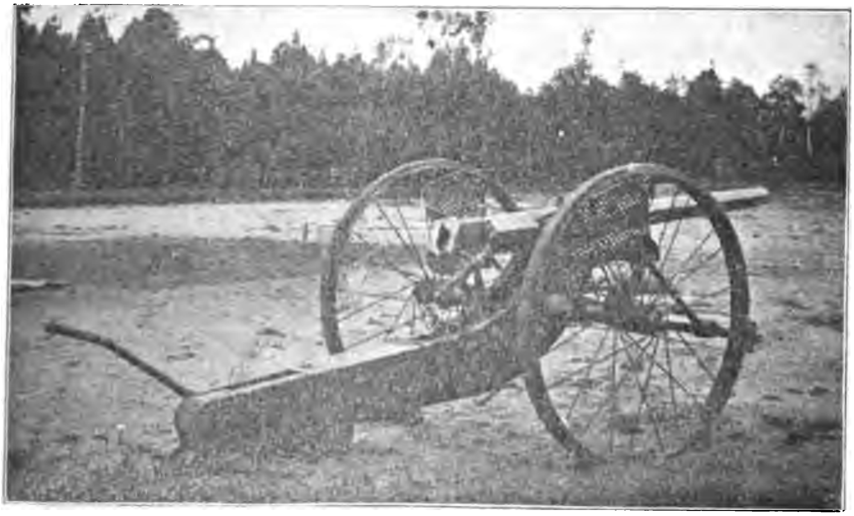
The wheel brake is only important for transportation, as the special methods of control disclosed in discussion of the weapon as a firing machine renders a firing brake unnecessary. In case, however, that the spade should refuse to act, the wheel brake should be able to take the place of a firing brake. The wheel brake must, therefore, be conveniently located near the breech. The automatic firing brakes have the drawback of controlling in the direction of the recoil only, whereas an ordinary wheel brake works both ways and can also serve, as was explained before, to brake the forward run of the gun.

The hub brakes referred to in connection with firing brakes can be used to control the wheels. But as they make the wheels less suitable for usage on both limber and carriage, the Krupp factory prefers simple tire-block brakes, worked by a screw. The brake in two separate parts, with special block for each wheel, is the best, because with a double-combination device, it is much more difficult to obtain the same pressure on both wheels; also this gear is usually heavier. When the arrangement of the carriage permits, the blocks (on limbered guns) are attached behind, as the natural position for wheel brakes. In this way the mud on the wheels is scraped off, instead of accumulating on the brake block. (See, among others, sketch A of the gun with wire spokes, Plate VII). The brakes are applied by means of a handwheel, which is manipulated from the axle seat, whereby due regard is paid to their possible use as firing brakes. If the carriage has no axle seats, the brake is so arranged that it can be served from the limber or from the driver's seat. In some models no brake is applied to the carriage (Sketch B, Plate VII), but the limber has one instead. Without special reasons for such an arrangement, the brake on the carriage is preferable.

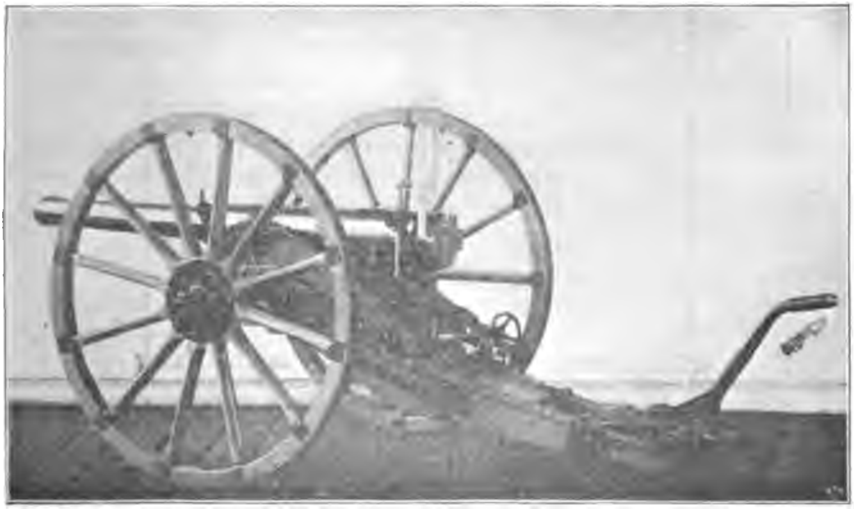
AXLE SEATS.

The desirability of axle seats has been much discussed. The Krupp factory does not think the question of whether they should be used or not of much importance. On guns of the horse batteries, axle seats are superfluous. It was impossible to apply them to narrow-gauge carriages, because sufficient space is lacking between the gun on the top carriage and the wheels. In all other cases, Krupp field guns, in accordance with the wishes of most artillery services, are fitted with axle seats. The increased weight of carriage is small, in all about 30 kg., a weight corresponding to what would otherwise be required for the extra seats on the limber. Seating part of the gunners on the carriage has the advantage of properly dividing the entire weight between the forward and rear axle, and makes the service of the brake when traveling easier. If more than three men are carried on the

PLATE VII.



A.—2.56-inch rapid-fire field gun, with vertical wedge fermeture, on field carriage having wheels with steel rim and wire spokes, with tire-traveling brake, axle seats, and hydraulic spade. Track gauge, 59.84 inches.



B.—2.76-inch rapid-fire gun, with screw fermeture, on field carriage with simple tongue spade with Belleville springs, without traveling brake or axle seats.

limber, all over this number must ride backward ; the whole floor space is thus crowded and the men sitting backward are in a specially dangerous position, because if they should fall off they would be run over by the carriage.

LIMBERS AND CAISSONS.

GENERAL REMARKS.

The most important part of the constructive development of the limber, consists in the best possible arrangement for packing the ammunition. Gauge, diameter of wheels, and weight of wheels are all determined by the corresponding parts of the carriage. The axle, hounds, pole, sockets, accessories, and tools, are all reduced to small dimensions on account of their weight. There remains the arrangement of the limber chest and the interior packing of the ammunition.

The limber of the field artillery has to fulfill many requirements. It must not only be the means of transporting the gun, but must serve to transport part of the ammunition and the cannoneers, and finally it must form part of the caisson. This last point of view may even become the deciding one for the construction of the limber, and is important in determining the whole gun model ; the limber must be lighter or heavier, according to whether it is only to serve as the forward carriage of the caisson, or whether it is to be used as forward and rear carriage, because the weight of the completed piece and the capacity of the caisson, are fixed at certain decisive limits. It is necessary in order to equalize the work of the horses, that, in distributing ammunition wherever the guns are in service, the weight of the pieces and that of the caissons should correspond as nearly as possible. The result of building the caissons as double limbers with the similarity of gun and caisson limber, is a weight of limber corresponding to the weight of an unlimbered gun. Without axle seats the forward axle would carry a load equal to that of the rear axle. This distribution of weight which has been proven unsatisfactory for vehicles of warfare, is still more unsatisfactory because only two men sit on the gun carriage, whereas the limber carries three, and usually also one day's feed for the horses. The piece (gun and carriage) bears too small a proportion of the entire weight, and the result is that the system when ready for transportation proves to be unsatisfactory from the point of view of ballistic effectiveness.

Under these circumstances, Krupp's factory allows the limber to be merely a limber—that is, a fore carriage, and divides the load of the vehicle between the two axles, so that without axle seats 45 per cent. of the weight falls on the front axle and 55 per cent. on the rear axle. As the essential parts of the front and rear carriages (wheels and axles) are equally heavy, it is not difficult in distributing the weight to allow for ammunition on the rear carriage, one and one-half times the limber capacity.

Counting two caissons for each gun, taking any 7.5 cm. (2.96 inch) Krupp gun for example, using the ordinary caisson rear carriage, the distribution of ammunition would result as follows:—

Gun limber		32 rounds.
Caisson limbers	2 × 32 =	64 rounds.
Rear carriages	2 × 48 =	96 rounds.
Total		192 rounds.

The use of double limber as constituting caisson would show about the following result:

Gun limber		36 rounds.
Caisson limbers	2 × 36 =	72 rounds.
Rear carriages	2 × 36 =	72 rounds.
Total		180 rounds.

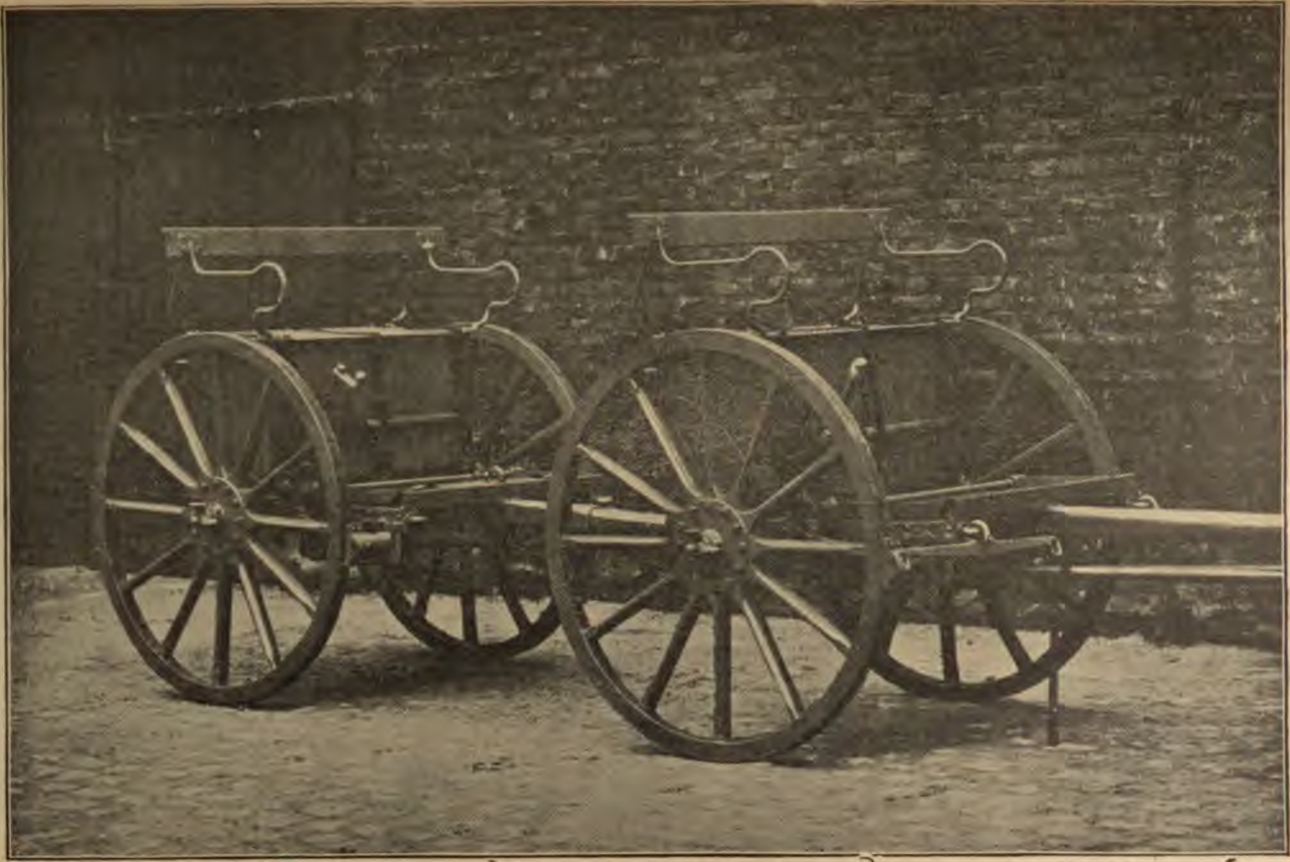
With the use of the ordinary caisson rear carriage, a larger supply of ammunition is obtained with the same number of horses and vehicles, and this condition becomes more favorable the greater the number of caissons the battery carries.

The double limber would not be preferable to the caisson of the ordinary construction, even if it were possible to reduce the weight to two-thirds of that of the gun, and that of the loaded simple limber to one-third of the same, in order to hitch four horses to the caisson, each of which would have the same load to haul as each of the six horses of the gun. Apart from the fact that such a reduction of weight could only be made possible by modifying the arrangement of the limber in favor of the unlimbered gun by leaving off the ammunition chest, or by reducing the number of projectiles in the limber, even this arrangement would not save horse power, as the following example proves: Allowing 27 projectiles for a lightened limber in a battery of six guns, with a supply of 192 projectiles for each piece, 6 × 192 = 1,152 projectiles would have to be carried requiring:

6 limbers	6 × 27 =	162 projectiles.
18 double limbers	18 × 54 =	972 projectiles.
Total		1,134 projectiles.

That is to say, for one gun three four-horse double limbers are not sufficient to transport the same supply of ammunition as two

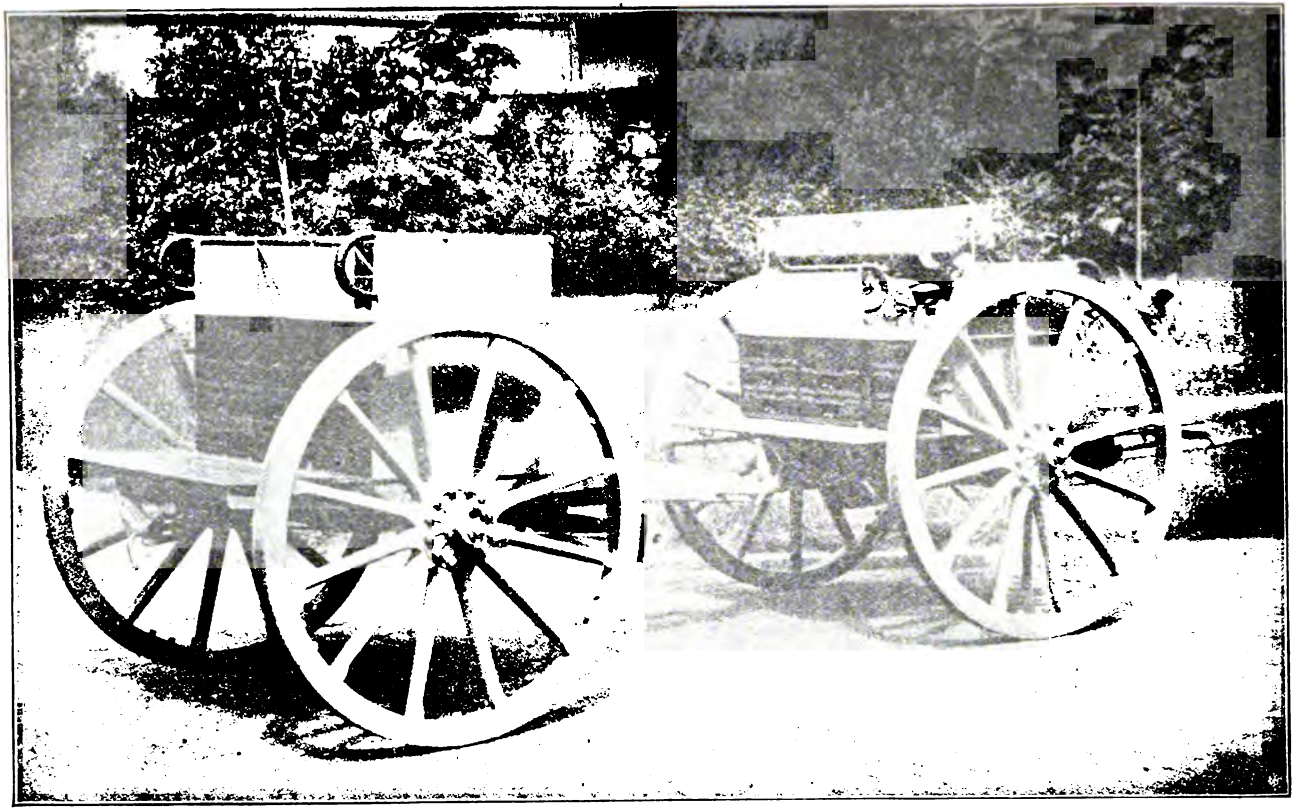
Caisson for rapid-fire field guns.



Double limber.

PLATE IX.

Caisson for rapid-fire field guns.



Caisson comprising limber and caisson proper.

six-horse caissons can carry; the length of column is unnecessarily increased and the expense is greater.

Taken all in all, the similarity of the limber and caisson is not of sufficient importance to be determining for the construction of the gun system and to put other considerations in the background. A similarity of detail of all limbers would present the drawback that a lot of superfluous tools would be carried, and in the case of a caisson (as double limber), either the front and rear wagons would be supplied with wheel brakes, or neither would have them.

Krupp's factory, in accordance with specially expressed desire of purchasers, has built a caisson as double limber. The picture on Plate VIII represents such a construction. A caisson of the usual model, with limber and battery wagon, is shown for comparison on Plate IX.

The two-horse, two-wheeled ammunition carts, recommended by some, are advantageous on hard, even ground and roads, and are desirable owing to their favorable use of horse-power and their very easy turning capacity, but on uneven ground the load must be taken by the horses all at once, and on soft ground each individual set of wheels has to break the track. The main drawback to the carts, however, consists in the lengthening of the column of march, as three two-horse, two-wheeled carts take up a length of several meters more, owing to the interval between the vehicles, than one six-horse four-wheeled caisson of the same carrying capacity.

FACILITY OF TRANSPORTATION.

The ordinary Krupp limber connections admit of the following angles of motion:

Turning angle, at least	80°
Angles of upward and downward inclination	+45° −90°
Independent angle of equilibrium	25°

The advantages of such a limber connection become apparent during transportation over hard ground and in diagonally crossing ditches.

The fastening of the limber chest is rigid or elastic, depending on the use of bearing springs. The necessity of setting the limber chest on springs has, however, not been demonstrated.

For poles, splinter bars, whiffletrees, and pole props, formerly all made of wood, Krupp's factory has gradually adopted the use of steel, after having first tried a combination of wood and steel. For splinter bars, whiffletrees, and pole props, this combination was carried out by filling a thin steel tube with wood, or else by running a solid steel wire center through the parts made of wood.

Neither reduction of weight nor any other advantage worthy of mention was thereby attained. It was especially noticeable that in the case of wood not thoroughly seasoned a mutual complement of the qualities of steel and of wood occurred only in newly made parts. The decisive consideration for the use of steel alone was principally the difference in the climates of the countries where the Krupp factory had to deliver its materials. In tropical climates wood is liable to be destroyed by insects and shrinks or swells from great heat or dampness. Finally, wood suffers more than iron or steel from bad handling, and is difficult to obtain well-seasoned and without defects. Reduction of weight has not been achieved by the use of steel. Splinter bars and whiffletrees are forged of solid steel bars, in flat or oval cross section, so that the greatest transverse moment shall be in the direction of the draft. The pole is made of rolled-steel plate, riveted on the underside. Hollow drawn steel poles, made of one piece, are heavier and have not proved desirable for use, being too rigid.

In order to lighten the draft of the horses and to spare them in driving over uneven, hard ground, Krupp's factory has lately used an elastic intermediary, applied between limber and horses. This arrangement is more to the purpose than an elastic insertion in the traces proper, because this latter method (so-called horse savers) requires double apparatus for each horse, which increases the weight and complicates the harness.

(To be continued.)

A DISCUSSION OF THE ERRORS OF CYLINDRO-OGIVAL PROJECTILES.

Translated from the French of General Douny in *Revue de l'Armée Belge* of November-December, 1899.

By J. M. WILLIAMS, 1st Lieut., 7th Artillery.

The progress recently made in methods of fire has given considerable importance to knowledge of the probable errors of projectiles.

This knowledge is indispensable in the calculation of the probability of hitting the target; it has, therefore, influence upon the choice of the guns and of the charges to be used in a given case. It enables us to decide as to the expediency of correcting the laying of the gun after a single shot or after a group of shots; often, it subsequently enters into the question of fire control; and finally it alone determines, from the point of view of accuracy of fire, the value of a system of guns, of a kind of charge, and of a type of projectile, as well as the value of changes that are being experimentally made in one or all.

Range tables give for different ranges the probable vertical errors, the probable lateral errors, and the probable range errors, for our various models of guns. These errors have, as is well known, been established in the following manner:—

A given piece having at one practice fired a certain number of shots over a given range, the points of impact in the vertical plane (so corrected, if necessary, as to pertain to the same sight elevation and sight deviation) are referred by means of abscissas and ordinates to the center of impact. The mean of the abscissas gives the mean lateral error; the mean of the ordinates, the mean vertical error.

Similar operations having been performed with data obtained at the same range, but at other times or with other pieces of the same model, give several values for these mean errors. Their mean represents the mean vertical error, for a great number of shots from several pieces of one model. By multiplying these approximate mean errors by the constant factor* 0.8453, we finally obtain the probable error for the range considered.

Proceeding similarly for other ranges we obtain the probable errors for other points of the trajectory.

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* Ratio of probable error to *true* mean error, or $\frac{r}{x}$; the approximate mean error being taken as the true in our computations. Tr.

In order that the results thus obtained may be accurate, and especially in order that they may be assimilable, the data must satisfy several conditions : the number of the shots fired must be large ; pieces of the same model must fire the same number of shots at equal ranges ; the platforms and the carriages must be identical; and finally, in order that the results may be very regular, it is necessary even that they be gotten under mean atmospheric conditions.

Rarely in practice do we have even one of these conditions completely satisfied. Therefore the probable errors obtained are generally rather inexact. However, a well known graphical method enables us to correct them by their relations amongst themselves, and to determine at the same time the probable errors for all intermediate ranges. For example, the results obtained for the probable vertical errors are referred to two coordinate axes, ranges being measured along the axis of abscissas and probable vertical errors along the axis of ordinates. We then trace a regular curve passing as nearly as possible through the points determined by these abscissas and ordinates; so an ordinate of this curve, which we call the curve of probable vertical errors, gives the probable error for the range indicated by the corresponding abscissa. It is evident that the curve cannot pass exactly through the points determined by experiment; so we must content ourselves with tracing it through them approximately by causing it, while preserving its regularity, to approach more or less nearly all points according as more or fewer shots were used in determining them.

The curve of probable lateral errors is obtained by similar processes. We can also determine the curve of probable errors in range in the same way ; or, as is more usually done, by dividing the vertical errors by the tangent of the angle of fall.

The method we have just outlined gives very uncertain results, unless in it we are able to use a large number of shots fired at various distances and under identical conditions. Experience proves, in fact, that the mean errors obtained by two series of ten shots from one and the same piece, sometimes differ widely: the ordinates gotten by experiment, then, cannot be taken as guides, unless conditions are such that we are justified in attaching importance to them. Moreover, the ordinates must not be too far apart; otherwise several curves might join their extremities, in which case the graphical method would be unsatisfactory.

From what precedes it is seen that in case of pieces of large caliber, in case of new ordnance, or in case of a system under test, the number of experimental shots being very limited the curve of errors will be very uncertain.

Again, if it is a question of testing a piece, this method will determine the greater or smaller accuracy with which it fires; but if the fire be inaccurate, it will be impossible, even by extending the test, to determine the cause of this inaccuracy. The evil will be known, but the remedy will remain unknown.

Our object is to remedy these difficulties, giving more accuracy, and therefore more weight, to the probable errors. To this end we shall study the influence of the various causes of deflection, both separately and in combination. We shall try to determine the share in the total deflection which is due, if not to each of these causes, at least to each of the groups of causes; and we shall endeavor to deduce from them the information necessary for correcting a faulty system of artillery.

Finally, by combining the influence of all the perturbing causes, we shall seek the rational equation of the curve of probable errors; with the aid of that equation we should be able to determine the curves much more accurately, provided we had as many points of sufficient weight as the equation contained constants. Should we have more points than there were constants in the equation, the method of least squares would enable us to obtain all the greater accuracy in the result.

At first glance the undertaking seems most rash: we halt before the multiplicity of causes of deflection; before the apparent impossibility of determining the value of many of those causes; and before the inadequacy of analysis for determining their effects. But a further investigation of the subject will prove that within certain limits it is capable of an approximate solution that suffices in practice.

We shall have in view especially the determination of the approximate mean errors, from which we shall be able to obtain the probable errors by multiplying by the constant factor 0.8453.

To avoid burdensome repetition of words we shall use interchangeably and indifferently the words* *erreur*, *écart* and *déviation*, although they are not entirely synonymous; and when it is a question of a mean of any one of the three, we shall have in mind, unless the contrary be stated, the approximate or empirical mean.

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* The translator has endeavored to use the corresponding American terms with accuracy; he has, however, used most frequently the word *error*, it appearing to him that the discussion is one of regularity of fire.—Tr.

THE LAW OF THE COMPOSITION OF ERRORS.

Perhaps it will not be useless to recall here this law and its corollaries.

Let us make the supposition that we are firing at a target, using under ideal conditions a perfect piece of a perfect system. The sight having been adjusted all the trajectories will coincide and the target will be hit at each shot.

Now let us suppose that we fire with this piece three separate groups of shots at the same range, assuming:

I. That in firing the first group all the conditions remain perfect except one—for example, that we use projectiles of slightly varying weight. This cause of accidental error will produce at the target a mean error* that we shall call e_1.

II. That in firing the second group there is also only one cause of error, but a different cause from that assumed in I,—for example, a faulty laying of the gun. There will result a mean error e_2.

III. That in firing the third group the two faulty conditions, previously assumed separately, are present togther, each in its originally assumed intensity, and produce a mean error E.

The theory of probabilities teaches that the total error E equals

$$\sqrt{e_2^2 + e_1^2}$$

so that it may be represented by the hypothenuse of a right-angled triangle of which e_1 and e_2 are the sides.

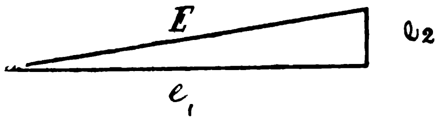

Fig 1

If other partial errors are added to the two, the total error will be

$$E = \sqrt{e_1^2 + e_2^2 + e_3^2 + \cdots};$$

and we shall be able then to find it graphically by combining the partial errors with one another, constructing right angled triangles.

This law has two corollaries that are very important for our purpose.

1st Corollary. Let us suppose that two very unequal errors are to be combined. At once it is seen that the smaller cause of error has scarcely any influence upon the total error, E being practically equal to e_1.

---

* *Error* is used here in its literal, not its technical, sense.—Tr.

As a numerical illustration let us take $e_1 = 1^m$ and $e_2 = 0^m.15$, then

$$E = \sqrt{1^2 + 0.15^2} = 1^m.01$$

It is evident that for our purposes, an inaccuracy of a centimetre in an error of a metre is entirely negligible. Hence: If with one cause of error producing a given mean error, this be combined with another imperfect condition that alone would produce a mean error equal to only 15% of the first, the second cause is of no force in the combination.

2nd Corollary. In the relation

$$E = \sqrt{e_2^2 + e_1^2}$$

two of the quantities being known the third follows either by calculation or by the graphical method. But we must not forget that the errors are never very accurately determined: for instance, knowing the total error and one of its components, let it be required to find the value of the other; the drawing, as well as the calculation, indicates that, if it is the smaller error that is to be determined, the result will be very inaccurate, when the smaller error is very much smaller than the other component.

So again, considering the numerical illustration, if the values $E = 1^m.01$ and $e_1 = 1^m$ are known, e_2 will be found equal to $0^m.15$; but if we had made a mistake of a centimetre more or less in the value of E, e_2 would have been found equal to $0^m.2$ or to $0^m.0$.

Knowing the total error and one of its components, then, we cannot deduce the other accurately, unless the unknown component be the greater of the two.

If the components be very unequal, an approximate knowledge of the smaller suffices to determine the larger.

We shall repeatedly have recourse to these well known laws, for they are the foundation of our discussion.

EQUATIONS OF THE TRAJECTORY.

For reasons given later, we have concerned ourselves in this discussion particularly with the errors of our old 8 and 9 centimeter* field projectiles, which are fired with initial velocities ranging from 380 to 350 metres. We have proved† that, in this case, the assumption that the resistance of the air varies with the fourth power of the velocity is the best, and gives results that are quite sufficiently accurate : we shall, then, make that assumption in this discussion. We get as a result the following relations :

---

* Corresponding respectively to our 3.2-inch and 3.6-inch field guns.—Tr.

† *Revue Mil. Belge* for 1886.

$$(1) \quad y = x \tan \varphi - \frac{g^1 x^2}{2 v^2 \cos^2 \varphi} \left(1 + \frac{2}{3} kx\right)$$

$$(2) \quad t = \frac{x}{v \cos \varphi} \left(1 + \frac{1}{2} kx - \frac{1}{6} k^2 x^2 + \dots\right)$$

$$(3) \quad z = B t^2.$$

in which

x = range ;

y = ordinate ;

z = divergence, or lateral deflection from plane of fire ;

φ = true angle of departure ; i.e., elevation and jump ;

v = initial velocity ;

t = time of flight ;

$g' = g - g''$ = force of gravity so modified as to allow for the vertical deflection produced by a mean force mg'' ;

$k = A \frac{R^2}{m} v^2$ = coefficient ot the resistance of the air, and constant for one trajectory ;

A = constant ;

R = radius of the projectile ;

m = mass of the projectile ;

B = constant.

Our discussion will be founded upon the equations given above. Each of the causes that influence the trajectory, and consequently the accuracy of fire, are represented either directly, as in the case of the angle of departure φ and the initial velocity v, or indirectly, as in the case of the resistance of the air, whose very complex effect is included in the coefficient k, in g', and in the constant B. However, it must be remarked that in these equations it is supposed that the air is still, while eventually we shall have to take account of the important influence of the wind.

VERTICAL ERRORS.

Classification and Examination of the Causes.

In order to use in our discussion the equation of the trajectory, we shall divide into groups all the causes of error ; the method of proceedure is clearly indicated by the form of this equation.

We shall put in the first group all the causes of error that affect the angle of departure φ. These are the errors of setting the sight and of aiming ; the eccentricity of the projectile ; the vibrations of the piece ; and the reaction of the carriage and the ground. We shall not add the irregular action of the gases upon leaving the muzzle, since this can affect only the first elements of the trajectory.

The powder gases having ceased to act at 20 or 30 metres from the muzzle, the center of gravity of the projectile advances along the prolongation of the last element of the curve that it was describing under the combined action of the gases and the force of gravity; neglecting the resistance of the air, the trajectory would now be governed only by the force of gravity and the initial velocity v: the form, the weight, the rotation of the projectile would have no influence. Under these circumstances the only errors that might enter would be those due to the variations of the initial velocity: the second group, then, will include only these variations. Finally, the air acts upon the translation of the projectile by its resistance; and by its motion, as wind. We shall put, then, in the third group these causes of error, here we must encounter the influence of irregular rotations, various shapes, and unequal masses in the projectile, and of unstable density and varied motion in the the atmosphere.

All the causes of error, whatever be their nature, are thus accounted for in these three groups.

1st Group. Errors produced by the variation of the angle of departure, φ. It would be impossible to determine the influence of each one of the causes in this group, so we shall confine ourselves to determining the total error produced by them in combination: we shall thus neglect no cause of error, however small may be its influence. Nevertheless, we are going to examine separately those causes that give occasion for interesting remarks.

Errors in setting the sight. The angular errors that result from this cause are evidently independent of the range. Not accurately to determine their values, but simply to form some idea of the errors they produce at the end of the range, we may remark that the mean accidental error in setting the sight scarcely exceeds $\frac{2}{10}$ of a millimetre. This produces at 1000 metres, in firing 8 or 9 centimetre guns, an actual error of about $0^m.10$, and a probable error of $0^m.10 \times 0.845 = 0^m.0845$.*

Now, according to our range tables, the probable error at 1000 meters for our old field guns is about $0^m.15$; this is the resultant value of errors of all causes. If, then, we suppose that in firing two separate groups of shots, there be in one case a mean error of $\frac{2}{10}$ of a millimeter in setting the sight, and in the other case a perfect adjustment, we shall find, according to the law of the composition of errors, that the probable error (from all causes) will reduce in the second case to

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* Most of the numerical illustrations in this article have as their object the showing of relative values; i.e., percentages. For this reason the translator has not reduced the metrical figures to their English linear values. Here, though, it is interesting to observe that an error of 0.008″ in setting the sight will cause at 1100 yards, an actual error of about 4″, or a probable error of 3.38″.—Tr.

$$\sqrt{0^{m}.5^2-0.0845^2}=0.^{m}49.$$

Neglecting the error in setting the sight, then, would have diminished the probable error only $0.^{m}01$ in $0.^{m}50$.

From this example it appears that it is with reason prescribed in the regulations for aiming competitions, that perfect coincidence of the blade of the slide with the graduation line of the sight need not be striven for.

Error in aiming. This also, observation has proved, is an angular error; that is to say, it corresponds to an increase or a decrease in elevation, upon which distance has no effect.

Good gunners make mean accidental errors that scarcely exceed 2 or 3 tenths of a millimeter. Their effect is, then, similar to the case we have just discussed; so we may conclude that not too much importance is to be attached to errors that arise in aiming at a well defined target.

Inclination of the trunnions. This inclination causes in the vertical projection of the trajectory the same irregularity as a diminution of the elevation; but when it is a question of target practice, we being then careful to place the wheels upon nearly the same level, or when it is a question of distances not exceeding 3000 metres, the diminution of elevation is not more than one or two tenths of a millimetre and has no effect upon the accuracy of fire.

It is otherwise in the case of the horizontal projection, when the firing is not done upon a well leveled platform.

Eccentricity of the projectile. The center of gravity of the projectile, when it happens to be not in the axis of the bore, describes about this axis a helix, whose radius is the eccentric distance, and whose twist is the twist of the rifling.

By developing the cylinder upon which the helix lies, we shall obtain the angle that this curve makes with the elements of the cylinder, or with the axis of the bore, this being parallel to those elements. This angle is the angular deflection Ψ due to the eccentricity.

Let us suppose, for example, an eccentricity of $0.^{m}0005$ in a projectile of 8^{c}; the twist of the rifling being $47\frac{1}{2}$, or one turn in $3.^{m}80$, there results from a well known property of the helix

$$\tan \psi' = \frac{2\pi \times 0.0005}{3.8} = 0.00085.$$

The deviation from a target at 1000 metres would, then, be $0^{m}.85$; and according to the position of the last element of the helix this deviation would be vertical, horizontal, or between the vertical and horizontal. It is seen how important the errors due to eccentricity may become, and therefore how important a factor in the accuracy of fire is the exact centering of the projectile. It is also noticed that the deviation due to eccentricity varies inversely with the twist measured in linear units (or directly with the twist considered as a ratio, as in the American service); and this presents a good reason, in addition to many others, for diminishing the twist measured in linear units (for increasing the twist considered as a ratio), only so far as is strictly necessary for assuming the stability of the projectile's axis of rotation.

Bending of the carriage and giving of the soil. It is well established that the recoil begins before the projectile leaves the bore: we may conclude, then, that the bending of parts of the carriage also precedes the departure of the projectile, and therefore is capable of affecting the angle of departure.

First, let us consider the bending of the flasks. The force transmitted by the trunnions to their beds, carries backward the upper part of the flasks; and, before the motion can have been communicated to the whole carriage, this upper part experiences a slight rotation in the direction shown by the arrow (fig. 2). This tending toward rotation is manifested in a bending of the flasks somewhere about the middle transom, hence results a lowering of the breech.

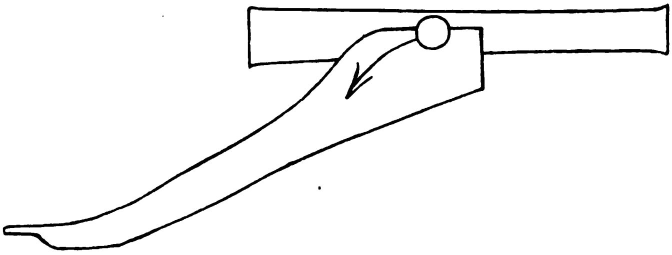


Fig. 2.

This depression of the breech is increased by the bending of the middle transom. We have for a long time been taught that when the axis of the trunnions is in the same plane as the axis of the bore, the pressure of the gases upon the bottom of the bore is directly counteracted by the resistance of the trunnion-beds, and cannot produce any tendency in the piece to rotate about the trunnions: but this reasoning would be correct only in case the trunnions had no thickness, or perhaps in case they were perfectly fitted and were held fast in the flasks. As a matter of fact, with the 8 and 9 centimetre guns they often have a certain play, being supported upon the bottoms of the beds (fig. 3). In this case the pressure of the gases has a considerable moment about the point of support, and produces a bending of the transoms and of the flasks: hence the breaking of transoms as a result of firing.

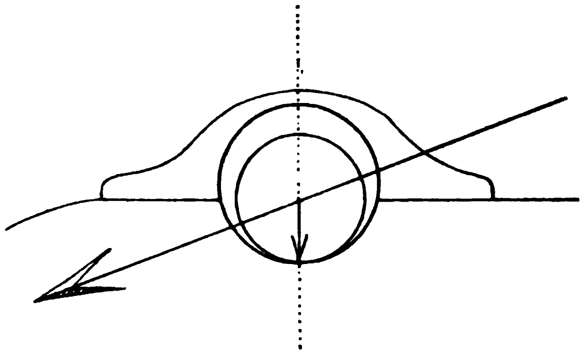


Fig. 3.

The bending of the flasks and of the middle transom and the lowering of the breech, explain the jump, that is to say the difference between the angle of departure and the angle of elevation. It is known that the first element of the trajectory always makes with the horizontal an angle greater than that with which the piece is aimed. Experience has shown that the jump of the 8^c gun is about 12′, and that there results from this at 1000 metres a vertical deflection of $3^m.45$. A bending of $0^m.0025$ in the flasks near the transom would suffice to cause this deflection.

The soil yielding under the trail can also contribute to the elevation of the point of impact.

We have not here to concern ourselves with the jump itself, it being a constant deflection for which the sight scales correct; but rather with its accidental variations, these being causes of *errors*. We cannot undertake to measure these variations; we shall simply state that the smaller the jump, the smaller will be its variations. From the point of view of accuracy of fire, then, there is an evident advantage in employing rigid metallic carriages, or in permitting the piece to recoil freely in one direction for a certain length of time.

The variations in the jump are not strictly independent of the range, since the inclination of the piece increases with this distance. But if, in the case of direct fire between 0 and 3000 metres, for example, with the guns we are considering, we take as our standard the bending which occurs with the mean elevation given for the ranges between these distances, then the bending caused by firing at the extreme distances, 0 or 3000 m, can differ but little from that standard. A first proof of this will be found in our already published article on the trajectory of the 8^c gun; where we have given very accurately the actual heights of sight-notch above the gun, having used in the calculations a constant angle of jump. A second proof of the same fact is found in the principle of the rigidity of the trajectory; for that principle could not stand, if the angle of jump varied sensibly with the inclination of the piece.

We are all the more justified in admitting here this constancy of the angle of jump, and consequently of its accidental variations, since we shall have to consider in what follows only the resultant of all the angular errors that affect the projectile upon its departure. If that particular error resulting from the irregular bending of the carriage were very slightly influenced by the range, that influence would be still much diminished in the general resultant, since the other component errors are unaffected by it.

Recoil. The recoil begins before the projectile has left the piece; if the axis of the piece does not move parallel to itself, there will generally result a lateral displacement; and if the piece should not be on a well laid platform or on very regular ground, there would also result a vertical displacement. It is, then, absolutely necessary that all possible precautions be taken to limit or to direct the recoil in such a way as to leave unchanged, during the first moments of recoil, both the elevation and the direction of the piece.

Irregular action of the gases upon departure. It is admitted that the gases of the charge still act upon the projectile at about twenty metres (22 yards) from the muzzle: some have even maintained that to their action is due the jump, claiming that expansion being checked by the ground, the density of the gases must be greater underneath the projectile. But this claim has not been verified by experience, for the same gun does not require greater elevations when fired from the crest of a hill than it does when fired in a sunken battery: nor does the projectile, when fired near and parallel to a wall, deviate sensibly in the opposite direction.

However, it seems indisputable that, if the action of the gases upon departure is irregular, there may result a slight variation in the angle of departure and in the plane of fire, and a sensible deviation in the course of the projectile.

It is the same with the *vibrations* of the piece.

Summing up, each of the causes of error that we have just examined produces an error in the angle of elevation and an error in the lateral direction, both errors being independent of the distance: the sum of the effects of these angular displacements of the piece is accounted for in the mean vertical error $\Delta \varphi$ and the mean horizontal error ψ.

From the examination of the different causes of angular errors, we conclude that the reactions of the carriage and of the ground, and especially the eccentricity of the projectile, ought to be the controlling causes of the whole group.

(To be continued).

PROFESSIONAL NOTES.

TACTICS.

With the Artillery in Natal.

By Captain C. Holmes Wilson, R. A.

Ladysmith, March 5.

I beg to send you a few rough notes on some of the deductions to be drawn from the operations for the relief of Ladysmith. They are penned under the disadvantages of campaigning, and I must, therefore, beg that excuses may be made for their crudeness. I only write them in the interest of the Service.

The effect of artillery fire is, perhaps, disappointing. It has scarcely produced that annihilating effect that some of its more ardent supporters have constantly claimed as one of its special characteristics; but then we can scarcely judge the value of some of its peculiar properties at present. The Boer guns have never been massed, and the Boer shells have fortunately been more often blind than not. In the last engagement, however, we had ample proof of what our artillery can do, and it is due to them and the effect of their fire that we are in Ladysmith now. The fight by Monte Cristo, the capture of •Hlangwane, and the occupation of Colenso led up to the bombardment of the Pieter's Hill position and the relief of Ladysmith. Colenso, that had defied us, Hlangwane, that had frowned on us, were left smilingly behind, and the Tugela crossed with the feeling that it would no longer be a formidable obstacle across our forward path. It was not however, till the river had been crossed that the strength of the Boer position could be realised in full. Whether viewed from the Ladysmith road or the kopjes behind Colenso, the difficulties of the task attempted on December 15 were equally plain. Standing in a gun emplacement close to the road, in which the Boers had had two Creusot guns, the plain below could be clearly seen as far as the camp at Chieveley. On the hill there was scarcely a kopje that had not been used for cover, whilst the road was studded with sangars, and the ground below it crossed by trenches, against which it would have been hard to produce very much effect with shrapnel shell. Even under the river bank the ground was hollowed out into holes in which the enemy must have been completely sheltered during the artillery attack. From their side the Boers must have seen every movement on the plain below. The dongas, the track, and even stones were clearly visible on the ground across which the column had advanced to Colenso on December 15. In addition to this the windings of the river are enough to deceive the most careful students of the maps, and it is doubtful whether the position of the drifts were perfectly understood when the advance began in the first attack on the Boer position before Colenso.

At the second engagement the situation was reversed. The artillery that had fought at Colenso on December 15, had been supplemented by the addition of a howitzer battery and several other heavy guns, so that the contest on the Tugela on February 27 was a very different action from the one-sided affair that had ended in our retirement two months and a half before. The weight of metal had turned the scale, and experience had taught us how to deal with an enemy whose real strength lay in his extraordinary mobility and the power it gave him in regard to the choice of positions and repulse of flank attacks. To deal with the artillery without praising the infantry would, however, be impossible. The artillery prepared the way for the infantry, but it was the infantry who completed the task and turned the half-finished fight into a victory; it was the infantry who dashed madly on across the bullet-swept plateau towards the trenches from which the death hail was belched by the Boers. It was the infantry who held the position when it was captured; it was they who spent the night in sangars without any other cover than their thin khaki; it was they who suffered, and it was they who lost; it was they who stuck to their march, and won us one of the most remarkable battles that has ever been fought by the British Army since Waterloo.

The Boer position was a strong one. Flanked on the left by Cingalo and Monte Cristo, it ran over Hlangwane across the Tugela to Grobler's Kloof on the right. Opposite Colenso a line of low kopjes faces the river, and behind it a higher bank of broken hills shoots out from one of the spurs of Grobler's Kloof, and runs parallel to the streams as far as Monte Cristo, where it culminates in a pointed crag on the opposite bank. Viewed from Chieveley, the Boer position as a whole looked perfect; from right to left it rested on important heights, and in front of Colenso it was protected by the river and flanked by Hlangwane, which was strongly held. It, however, had its weak spot, a spot that even artificial fortifications could not overcome. The Tugela divided the position in two; the broad stream, with its mimosa covered banks which sweeps past Colenso in a silvery streak swerves sharply to the left a mile below the town and separates Hlangwane and Cingalo from the kopjes near Colenso and the heights behind them. Consequently, once Cingalo was captured and Monte Cristo turned, Hlangwane stood alone an isolated outpost on the southern bank of a rapidly-running stream. On the other hand, if Hlangwane had been attacked at first the enemy's front would not have been broken. he would still have held the heights on the opposite bank of the river and the hills on our right. Cingalo and Monte Cristo were consequently the *points d'appui* of the attack—the only keys that were likely to lead to the capture of the position.

On February 14 the battle began with the occupation of Hussar Hill, a low-lying ridge to the south of Monte Cristo and Cingalo. On the 15th we had two 5-inch guns and five naval 12-pounders on Hussar Hill, in addition to the field batteries which were under cover near at hand. The Boers then occupied a flat-topped plateau, which connected Monte Cristo with Hlangwane and formed an important part in their general line of defense. This hill was heavily bombarded on the 16th and 17th, and on the 18th it and the heights of Monte Cristo, to the right, were carried and the Boer position turned. On the 19th our army wheeled to the left and pressed the enemy back towards the river, and on the 20th the Boers vacated Hlangwane and retired across the Tugela. The first stage of the attack had now been brought to an end, and the way for a further advance prepared. The original Boer position had been turned, the kopjes in front of Colenso rendered untenable, and the enemy pushed across the river. The ground they had vacated was strongly entrenched. Hlangwane itself was a network of entrenchments, and every point of importance had evidently been strongly held. The trenches were very deep and hollowed out on the side next to the enemy; the parapets were strengthened by the use of sandbags, and were strong enough to resist artillery. In these works the Boers must have been absolutely safe from shrapnel fire. They could remain under cover during the artillery preparation, and come out to oppose the advance of the infantry as soon as the general attack began. The trenches themselves were very dirty, while the camps in rear of them were absolutely filthy. When these trenches are seen and their strength considered, the wonders performed by our infantry may be properly understood. No praise is high enough for them.

Throughout this period the part played by the artillery was far from being devoid of interest. The Boers brought up a heavy gun, but removed it as soon as their line of retreat was threatened. The most remarkable feature of their artillery tactics was, however, the successful manner in which they managed to conceal their guns and "pom-poms." The "pom-pom" was always to the fore whenever the infantry attack commenced, and the "pom-pom," though it has never been considered very formidable before, has at present more than earned a reputation fitting it to be classed in the category which covers that miscellaneous collection of pieces usually described as field guns. The "pom-pom" is a remarkable weapon. It has never been seen. It troubles our men more than any field gun the Boer possesses, and it embodies all the principles of a quick-firing field gun without possessing any of the disadvantages that have prevented the adoption of this description of *matériel* in our Service. The knowledge of its existence is demoralising, because oar guns have never yet succeeded in putting any particular piece out of action for any length of time, whilst the rapidity of its fire has on more than one occasion led to serious loss. Here we have a quick-firing field gun embodied in a minor degree, and there is not a man who has seen the fighting in Natal who can say that the "pom-pom" is not the most destructive of the destroying weapons—next to the rifle—possessed by the Boers. It is in a lesser degree what we might expect on a larger scale from a properly constructed quick-firing field gun. It can act at the decisive moment—act once, twice, thrice, and yet be ready to act again. Yet, on the other hand, there is no necessity to throw away this power. It is a power that can be nursed and hurled forth at the proper time ; it is a power that may repulse an attack or decide a fight; it is a power that we as a nation cannot afford to ignore. If any doubt me, I would beg them consider the other side of the question. If we take our field gun as it is, consider our enemy always as likely to be Boers, who protect themselves by earthworks, see what the result will be. Field guns against earthworks are out of place. If in the future we have to contend in this campaign against an enemy who shelters himself perpetually behind trenches, I say, without hesitation, that the day for 15-pounders has passed. The only way to deal with such a foe as our present is to approach him by parallels in which siege guns have been placed.

In the present war we, of course, can only view the quick-firing question from the opposite side. We have always attacked, and rarely been attacked, except when our infantry have been unsupported, as at Vaal Krantz. Now, it is obvious that it would be useless to use a quick-firing field gun against entrenchments if every shell that was fired was useless. Look at the question from the other side. Take our advance on Colenso on December 15; our attack on the heights to the left of Spion Kop on January 20, or our feint in front of Brakfontein on February 5. In all these cases quick-firing field guns properly placed would have reaped a harvest worth the threshing. Viewing the matter from another standpoint, improvements in firearms have undoubtedly increased the use of cover. Cover is not always easy to find. Cover for a six-gun battery is a *rara avis*, unless guns are put behind a hill; cover for a few guns is often easily found. If a few guns—say three—can be made to do as much as six, why use the six? It only gives the enemy a larger target. This applies to the attack as well as to the defense. In the defense the Boers have proved to us that a few guns in carefully selected places are hard to silence; in the attack we have seen that batteries have often had to be exposed, whereas a few pieces might have sufficed to provide for all that had to be done. In our lengthy struggles in Natal the artillery duel has often dragged out over days. On some of these days many of the batteries brought into action have never fired a round, though they were liable to be fired on themselves. What was the reason of this? The officers in command were not to blame, but they had to use all their guns whether they were exposed or not, because they could not rely upon a few being able to do the work, though they might have been concealed and kept out of danger. The guns were unequal to the occasion, and if any sudden emergency had arisen they would have failed. The result was that long lines of batteries had often to be exposed when under more favorable circumstances they might have been concealed. The quality of the Boer shell often saved us, though they sometimes managed to secure an "effective" shrapnel fire. There is a strange tendency among our men to shun the use of cover. If you put a soldier on a hill, he will more probably than not stand up. If you put any guns on a kopje they will up on to the sky line and never think of digging. Give the Boer sufficient time and similar conditions, and he will sneak up under the hill or cover his gun with twigs, and make an epaulment for it besides. In such an unequal contest we are bound occasionally to suffer losses besides those incurred in making attacks. It is difficult to make the Britisher understand anything in the shape of what I may call tricky tactics. He has been taught to do his fighting in a thoroughly straight-forward way, and even when his life is at stake he refuses to take advantage of what appear to him to be mean devices. If the relieving force had shown any weakness it would not have been able to fight four pitched battles, one of which lasted for a week, whilst another extended over a period of more than fourteen days. Both, however, have done well, particularly the infantry, whom the nation has every cause to be proud of. As to the remainder of the fighting, I hope you will permit me to describe it later.

—*Army and Navy Gazette*, April 7, 1900.

Night Communications in Fortresses.

By Lieutenant W. B. Spender, R. A.

To write about such a subject may at first sight appear superfluous. It is a matter that has evidently been before the Authorities and the result is seen everywhere in new telephone lines being laid down solely for "R. A. chain of command purposes" and very often quite independent of, and supplementary to those of the Section Commands. The new Siemens Halske Telephone Operator is undoubtedly an improvement on former instruments.

It is usual, I believe, for these R. A. telephone lines to converge from forts —often widely separated—to one point, the Fire Commander's post; and in very few cases, so far as I am aware, is there direct communication from one Battery Command to another.

How does this work out in action? A ship or fleet presumably hostile, is observed by one of the forts, and immediately the Battery Commander sends a telephone message to the Fire Commander. The Fire Commander may have as many as six or even more detached forts under his command; to each of them he has to send the information obtained, and his orders. No doubt he will begin with the work nearest to the supposed enemy, and afterwards to the others in rotation; but as one message to each fort can only be sent at the same time, there must be a delay of some minutes before the last battery receives it. With a fast moving target this might be fatal. In addition, any loss of time incurred at one fort means the same at the remainder; and even in the most perfect chain of command lines unavoidable accidents may occur —the bell refuse to ring, or the hearing be indistint owing to a thunderstorm, etc. Also there is always the possibility of mistakes in the transmission of messages and in consequence waste of time, more especially if the Fire Commander is sending different orders to each Battery Commander under his command.

The necessity for speed is greater as regards the transmission of information than that of orders; the former is required not only between fort and fort, but also between fort and ship, and the electric light and P. F. cells of the Submarine Miners. It would be a boon to communicate rapidly without notifying the enemy, if it were possible; but for the present secrecy does not seem compatible with quickness.

In the issuing of orders, rapidity is perhaps not so important as to keep the enemy ignorant of your intentions; but with regard to information of the enemy's numbers and movements, you are, at the worst, simply informing him that you are aware of things which he already knows; and although it may be desired to conceal your knowledge from him, this does not seem of equal vital interest.

In some stations this want has apparently been felt already and megaphones are being experimented with as a method for more rapid intercommunication. The results on the whole appear to have been satisfactory, but, of course, only for distances not exceeding half a mile. This otherwise excellent instrument is considerably affected by climatic variations and by the commotion of a battle.

If the above are real difficulties means to escape them might be found in:

1. Typewriting Telegraph (Stelje's patent).
2. Flare lights.
3. Signal rockets.

1. The first has the advantages of secrecy, and of being albe to transmit simultaneously to all the batteries connected to the Fire Commander's post by telephone lines, an exact copy of the Fire Commander's orders. Although this typewriter does not need much of an expert to work slowly, it must take some time to send a message by this means, and of course it is only available where telephone lines are laid.

In the defense of a channel or a number of channels, which is usually the duty of the Garrison Artillery, there would probably be guard-ships and patrol boats furnished by the Navy. Notice of an enemy obtained by these, should be sent to all the forts without delay. In this a rocket has the advantage over a typewriting telegraph, as also in the case of look-out and coast-guard stations on the coast to which lines are not yet laid.

2. Against the use of flare lights there are important arguments. A flare light although very certain to be observed at considerable distances, also demonstrates with considerable accuracy its position and objects in its vicinity. Their use, therefore, would allow the enemy not only to locate a fort or ship, but might also afford him additional and valuable intelligence as to its size and armament. This fault is so fatal, as to preclude absolutely the use of flare lights, without some radical alterations in their construction.

3. Signal rockets on the other hand do not offer the above objections. If the spot of ignition is invisible, it is impossible to define it at all from the ascent of a rocket; even the firing of several rockets from the same place would not assist an enemy's gunner to range, and scarcely in laying for line, especially if the rockets are not all sent off in the same path.

A more important fault is that rockets are worthless in misty weather. This is serious, but unless some better system is available it should not prevent their being used when possible. Lamp signalling at night has both the above objections in an exaggerated degree. One can only hope that foggy nights may not be available when the enemy attacks, or that the mist may so oblige him to slacken speed, as to render the telephone capable of carrying out its work in sufficient time.

But, it may be asked, what information can be conveyed by a rocket?

1. That ships have been sighted, probably hostile.
2. The position of these ships.
3. All that has been ascertained as to the enemy's numbers and the components of his fleet.

It would appear advisable to have at least two rockets for this purpose, of which the first might be an ordinary detonating rocket with a charge of 4 oz. of gun cotton audible from 8 to 12 miles. The loud report would attract the attention of the look-out men at each fort, etc. This rocket might also be easily used to demonstrate the direction of the object sighted by means of different colored stars, but it would not appear advisable that these stars should be of the floating pattern, which were better, I think, reserved for the 2nd rocket.

The second rocket is to describe and give the number of the enemy's ships. I fancy any fleet not exceeding 10 vessels could be easily shown by a rocket of somewhat the following construction—a signal rocket with the motive charge already fixed, with a small bursting charge above it. The head to be of thin metal and kept empty when stored, but to have a cap piéce made easily detachable with a bayonet joint. Before firing, the cap piece would be taken off, and a certain number of floating ligths inserted and wads to keep them in position, as required, and the cap piece put on again. This rocket could be filled and fired in 10 seconds, would be seen for a radius of from four to eight miles on a clear night, and would cost from 2s. 6d. to 4s. each.

The number of floating lights would give the number of the ships; and their color would afford the description of them according to a recognized code. For example the 2nd rocket on bursting shows three green and two red lights—this would mean that a fleet of three torpedo craft and two cruisers had been sighted.

A look-out man on sighting any suspicious object whatever would send down to the Battery Commander or other officer detailed. As soon as he became convinced that it was a vessel, he would, if it were not showing the pre-arranged friendly signal, on his own authority fire off the 1st rocket according to the direction of the ship (*e.g.*, if in the N. E. one with red stars, if in N. one with white, if in N. W. one with green stars).

The officer on arrival would determine the class of vessels attacking and give instructions as to the filling of the 2nd rocket.

It is probable that some system such as that suggested above, or a better one, has been contemplated, perhaps even arranged for in time of war; but it is doubtful if some practice is not necessary in time of peace.

So important is the discovery of ships—more especially torpedo craft—at night, that I believe one of the smaller continental powers, which has much to fear from attacks of this description, has specialists chosen for eyesight and trained in the use of night-glasses told off for his duty.

England's torpedo fleet is small in proportion to that of other European nations, and it is therefore advisable that the Garrison Artillery should be peculiarly prepared to guard against their raids.

It may appear desirable to have trained specialists similar to gun layers with some small extra-duty pay, so that in time of war there would be at least three per work in order to take reliefs of not more than one hour each.

Practice could be obtained for these men in conjunction with the Submarine Miners and perhaps a money prize and badge could be awarded in those stations where combined maneuvres with the Navy take place each year. At such times also communication between the guard-ships, patrol boats and the shore might be experimented on.

These men, except when actually employed as specialists would be available for manning the guns. If the 3 look-out men of each work were told off on mobilization to the same number on two guns, *e.g.*, as they are probably intelligent men, to number 4 on two guns, there would always be, (even when one was employed on look-out duties) two men available for duty as No. 4.

Oculists agree in saying that the power of observation at night is greatly a matter of practice. From one's own knowledge on board ship one perceives how sailors, who have to be on watch can always see steamers, and also objects which are not lighted up such as icebergs, long before the inexperienced passenger, no matter how the latter prides himself on the keenness of his eyesight. In the case of pilots this sense is developed to a marvallous degree of perfection.

To sum up it is suggested that there should be:

1. Gunners trained as look-out specialists sufficient for each fort and reliefs.
2. Rockets as a recognized means of communication between forts, warships, etc., at night.
3. Yearly combined practice with the Navy, where possible, in the various means of passing information.

—*Proceedings Royal Artillery Institution*, September-October, 1900.

DRILL REGULATIONS AND MANEUVERS.

Manual for 12-inch B L. Rifle, mounted on Barbette Carriage in an emplacement provided with ammunition lifts.

BY FIRST LIEUTS. ALFRED M. HUNTER AND EDWIN LANDON, 4th ARTY.

Name of Detail.	*Duties and Posts.*
Gun Commander (Sergeant)	Carries up range scale and difference chart and places them on shelf or table near telephone. *Post.*—At inspection, two yard in rear of loading platform. At drill, he goes wherever his presence is necessary.
Gunner (Corporal or private, duly qualified).	Carries up sight and places it on its seat. Removes sight before firing. *Post.*—On sighting platform, or on gun platform near azimuth pointer.

Breech Detail (4 privates, Nos. 1, 2, 3 and 4.

Nos. 1, 2 and 3 assist each other in putting on the sleeves. No. 1 carries up the chamber sponge and lanyard, and places chamber sponge on prop; No. 3 carries up two water buckets containing water, hand sponge and oil in oiler, and places them on loading platform convenient to the breech. No. 2 equips himself with primer pouch, primer key and wire, and with the assistance of No. 4 carries up translating roller and loading tray, placing them on loading platform convenient to the breech. Nos. 1 and 2 remove and replace breech cover, place translating roller in position, open and close breech, insert and remove loading tray, insert sections of cartridge and see that they are sent home, and with the assistance of No. 4, sponge out the chamber and the bore when necessary. No. 3 washes the breech block, breech box, gas check, screw tread, wipes dry the surfaces he has washed and then oils them. No 4 brings up the bore and chamber sponges when required, and the rammer. Nos. 1, 2, 3 and 4 assist in ramming the projectile. After the projectile has been launched off the loading tray, Nos. 2 and 4 swing it to on side. No. 2 serves vent. No. 1 fires.

Posts.—On loading platform, in two ranks, immediately in rear of the breech, facing it. Nos. 1 and 3 on the right; Nos. 2 and 4 on the left; Nos. 1 and 2 nearest the breech.

Charge Detail (4 privates, Nos. 5, 6, 7 and 8).

No. 5 carries up the bore sponge; No. 7 carries up the rammer; they place them on the prop. Nos. 6 and 8 carry up the prop, and the rope for the shot crane, placing the latter on the crane. Nos. 5 and 7 examine, and if necessary fill the recoil cylinders, being careful to remove both plugs of each cylinder, and replace plugs when cylinders are filled. They remove sections of cartridge from truck, while projectile is being hoisted, and after projectile is rammed home, hand them to Nos. 1 and 2. Nos. 6 and 8 bring up the charge from the lift on the truck; engage the hook on rope in eye of shot tray and run up projectile; after projectile is rammed, they run down the shot tray, replace it on truck, and run truck to ammunition lift. All these numbers assist in ramming.

Posts.—Nos. 6 and 8 left of shot crane; No. 6 in rear and No. 8 in front of crank. Nos. 5 and 7 one yard outside of carriage, facing it, and on right of carriage opposite to the posts of Nos. 6 and 8.

Traversing Detail (2 privates, No. 9 and 10).

Carry up traversing cranks and place them on the traversing shaft No. 9 and 10 traverse the carriage. No. 9 carries up funnel and oil measures for filling the cylinders, and places them near

	parapet convenient to the post of No. 5. No. 10 carries up wrench for filling plugs and places it convenient to the post of No. 7. *Posts.*—At the traversing cranks, facing the parapet; No. 9 on the right; No. 10 on the left.
Elevating Detail (2 privates, No. 11 and 12).	Nos. 11 and 12 remove and replace the muzzle cover and give the elevation. *Posts.*—At elevation hand wheels, facing from parapet; No. 11 on right; No. 12 on left.
Supernumerary Cannoners (2 privates, Nos. 13 and 14).	Assist Nos. 6 and 8 in hoisting projectile, and assist in ramming. *Posts.*—For inspection, on gun platform near outer hand rail directly in rear of loading platform; No. 13 on right; No. 14 on left.
Ammunition Detail.	*Ammunition Sergeant and* 9 *privates.*
Ammunition Sergeant.	Inspects cartridge room, shell-room, ammunition lifts, shell tongs, shell trays, and trolleys; fuzes shell when required, and exercises general supervision over supply of ammunition.
Cartridge Detail (2 privates).	Uncase cartridges and place them on track, place empty cartridge cases to one side.
Shell Room Detail (4 privates).	One of the detail assists the ammunition sergeant in fuzing shell; the other three run a trolley with empty shot tray attached over a shell; roll shell on tray; run trolley out to lift gallery; place tray and projectile on empty shot truck and run trolley back to shell room for another projectile.
Lift Detail (2 privates).	Run empty trucks off lift and run on the full ones; operate the lift.
Platform Detail (1 private).	Opens and shuts doors to lift; operates chocks of lift. Runs full truck off lift, and empty truck on lift.

At the command, *Examine Gun*, Nos. 1 and 2 remove the breech cover, fold it, and place it out of the way, place translating roller in position, open the breech and clear the vent; carefully inspect the bore, chamber, breech block, breech box, and breech mechanism; if necessary, No. 4 brings up the chamber sponge, and assists Nos. 1 and 2 in sponging the bore; No 4 replaces the bore sponge; if necessary, brings up the chamber sponge and assist Nos. 1 and 2 in sponging the chamber; after the sponging is completed No. 4 replaces the chamber sponge; if necessary, No. 3 cleans the breech, breech block, breech box and sleeve and gas check, and wipes them dry, he then oils all the surfaces he has cleaned; Nos. 1 and 2 close the breech after inspection; Nos. 5 and 7 mount upon the carriage, No. 7 taking with him the plug wrench, and mounting on the left of the carriage, removes the plugs from the cylinder on that side of the piece; he then hands the wrench to No. 5, who removes the plugs from the cylinder on the right of the piece; if the cylinders do not contain the proper amount of oil, No. 9 passes up the oil measures and funnel to No. 7, if necessary; after the cylinders are filled, No. 5 and 7 replace the plugs, screwing them well home; Nos. 9 and 10 test the traversing gear to see that it works smoothly, and, under the direction of the gunner test the azimuth indicator for adjustment; Nos. 11 and 12 remove the muzzle cover, fold it and place it out of the way, test the elevating gear to see that it works smoothly, and under the direction of the gun commander, test the elevation indicator for adjustment; they then give the piece a depression of about one degree; the sight is inspected and the level of the traverse circle is tested by the gunner; the telephone and other means of communication are tested by the gun commander.

At the command, *Load*, No. 2 removes the old primer and clears the vent; Nos. 1 and 2 open the breech; the breech, breech box and breech sleeve, gas check and screw threads, are washed off with the hand sponge by No. 3, who wipes dry all the surfaces he has washed and oils them; the chamber is sponged, if necessary, as prescribed under "examine gun," as is also the bore, if necessary, by Nos. 1, 2 and 4; after replacing the chamber sponge, (if brought up), No. 4 immediately brings up the rammer; Nos. 1 and 2 insert the loading tray; Nos. 6 and 8 go for the truck and bring it with the projectile and charge under the loading crane; they run up the projectile as prescribed under "Posts and Duties," with the assistance of Nos. 13 and 14, if necessary; Nos. 5 and 7 remove the sections of the cartridge from the truck and place them on the loading platform; when the projectile is at the proper height to be launched on the loading tray, the crane is swung around to the rear of the breech by Nos., 2 and 4; Nos. 5, 6, 7, 8, 13 and 14 mount upon the loading platform; No. 1 places the head of the rammer against the base of the projectile, and Nos. 1, 2, 3, 4, 5, 6, 7, 8, 13 and 14 take hold of the rammer on their respective sides, with the hand nearest the rammer, the odd numbers on the right, the even numbers on the left, the numbers being in the ascending order of their numbers from the breech to the rear, Nos. 1 and 2 nearest the breech; when the gun commander sees that all are ready, he gives the command, *Ram*; at this command the projectile is launched forward until its base is about thirty inches beyond the loading tray; Nos. 2 and 4 then swing the crane to one side and resume their places on the rammer; the gun commander then gives the commands, 1. *Home*, 2. *Ram*; at the first command, all the numbers, leaning well back, take a firm hold; at the second command, all working together, send the projectile home with all force possible; all quit the rammer, except Nos. 1 and 2, who withdraw it; Nos. 13 and 14 resume their posts; Nos. 6 and 8 run down the shot tray, replace it on truck, run truck back to lift, and resume their posts; Nos. 5 and 7 hand up sections of cartridge to Nos. 1 and 2; No. 3 holds the head of the rammer out of the way until the first (cone) section of the cartridge has been inserted by Nos. 1 and 2; he then places the head of the rammer against the section of the cartridge, and assisted by No. 4 pushes it home without unnecessary force; the second and third sections of the cartridge are pushed home in the same manner; Nos. 1 and 2 then insert the rear section, and push it home by hand until its base barely clears the gas check seat; Nos. 5 and 7 resume their posts; Nos. 1 and 2 remove the loading tray and close the breech; No. 2 inserts the primer, screwing it well home: No. 1 prepares the lanyard, handing the hook to No. 2 who inserts it in the eye of the primer. The breech detail remains upon or leaves the loading platform as directed. No. 1 or the gunner fires the piece. If lanyard is used to fire the piece, the firing number must be nearly on a line in the prolongation of the axis of the piece. A side pull usually results in breaking the wire of the primer. Meanwhile the gun has been approximattely laid in direction during the loading. (See cases, I, II and III, General Duties, Drill Regulations for Sea Coast Artillery).

For commands for firing, see General Duties, Drill Regulations for Sea Coast Artillery.

NOTES ON THE MANUAL.

Elevating and traversing details remain at their posts after the command, "Examine Gun," and carry out instructions for elevating and traversing. The gun can be traversed at any time during the loading except while the shot tray is being lifted from the truck.

The piece can be loaded at an elevation of about one degree. It is more convenient to load it at a depression of about a degree, and this depression has been prescribed in the manual. It should remain at this elevation during the loading.

The posts of the gun detachment given above are for inspection, and preparatory to the service of the piece. The gun commander and gunner go wherever their precence is necessary.

The reserve is posted for inspection, in two ranks near the left of the piece, facing from the parapet; at drill or practice, they will remain under cover wherever the gun commander may direct.

The post of a cannoneer when once assigned in the "Manning Table" will not be changed during the day's drill, except for good and sufficient reasons; the men must be made proficient in the duties of the posts to which they are assigned. The assignments may be for the day, week or month.

The posts of absentees from the gun detachment will be supplied from the reserve when there is one, and not from the gun detachment itself, unless it becomes necessary to drill with reduced numbers.

When the detachment breaks ranks at the command "Prepare for action (or drill)," the gun commander sees that the several numbers take the proper stores from the store house, and place them as directed.

At the command, *Replace Stores, Form Detachment*, each gun commander does as directed on page 80, Drill Regulations for Sea Coast Artillery.

When pressure gauges are used, No. 2 takes them out and hands them to the gun commander, receiving from him those for the next round. When used, the gas check of the guage is covered with a lubricant, and the screw threads of the guage are painted with red or white lead.

As soon as the piece is fired the breech detail return to their posts and immediately open the breech.

The gun commander superintends the loading until the breech is closed, when he gives the approximate elevation to the elevating detail. He then goes to the range scale and difference chart for more definite information.

As soon as the piece is fired, Nos. 11 and 12 go immediately to the elevating hand wheel and commence to depress the piece, and continue to do so until the gun commander commands *Halt*, when a depression of about one degree is attained.

Mounting Carriages for 12-inch B. L. R.

The accompanying plates illustrate a safe and expeditious way of mounting carriages for 12-inch B. L. R. from the parapet.

A travelling car is mounted on two parallel trestles, 12 feet 6 inches apart in the clear, and running from the parapet in front directly over the counterweight well. The different parts had been placed on the parapet by means of the engine and trestle used by the Engineer Department in the construction of the battery. Differential chain pulleys are attached to the car as shown in Plate No. 3, which is taken from parapet directly in front, and which also indicates the picking up of the lever arms from the parapet. No. 4 shows the same piece a few minutes afterwards being lowered into place. Nos. 1

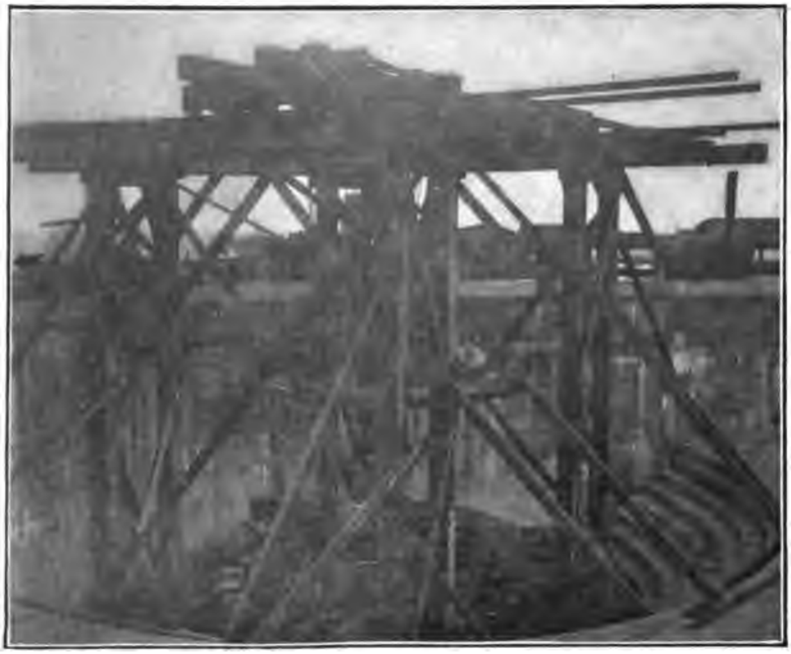
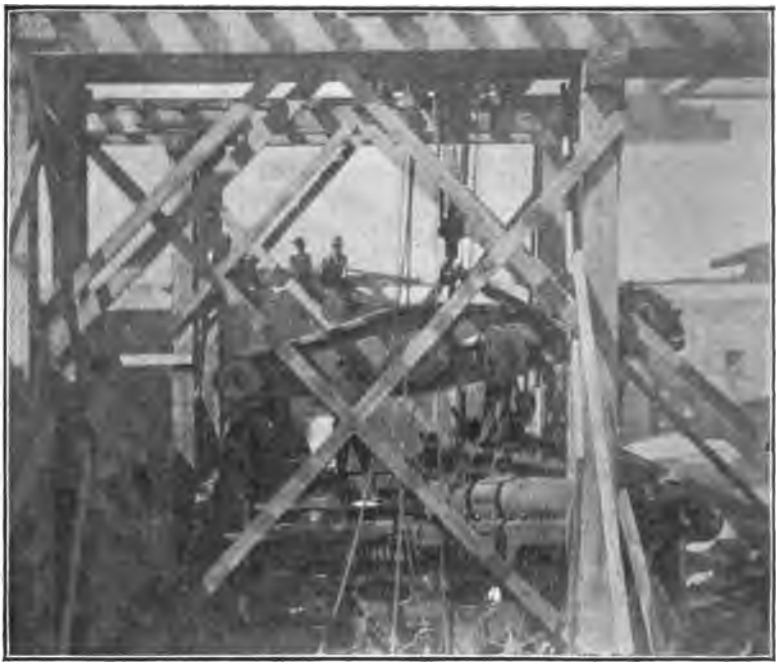


Plate No. 1.

No. 2.



No. 3.

No 4

and 2 show a racer half being lowered, No. 1 being taken from the parapet at side and No. 2 from platform directly in rear.

The plates are from photographs taken by me under orders from Captain Patterson, Post Commander.

Fort Morgan, Alabama,
Dec. 31, 1900.

ROBT. E. WYLLIE,
2d Lieut., 1st Artilllery.

PHOTOGRAPHY.

Telephotography in modern Warfare.

BY MAJOR J. B. LESLIE ROGERS, DEHRA DUN MOUNTED RIFLES.

It has become almost an axiom nowadays, that the British Empire, to its discredit, is always the last of the world powers to adopt the progressive discoveries of science for practical purpose. Countless instances could be cited to prove the existence of grounds for this general belief; and at the present moment even a semi-civilised people, like the Boers, are giving us many a severe object-lesson in this respect. Be the cause what it may, the fact remains that we are generally much too dilatory in taking up the many advantageous inventions and discoveries of modern times, more especially in matters military. With reference to the latter aspect of the question, we are, for instance, constantly being told with irritating reiteration, that such and such a reverse to our troops in Africa and elsewhere was caused by want of reliable information, defective scouting, ignorance of the configuration of the country, and so on, *ad nauseam*. These, however, are mere excuses, and excuses cannot be accepted as irrefutable reasons, or as any palliation of avoidable mistakes. The positions held by an enemy and the physical features of the seat of war *ought* to be known to every leader of troops; and with wireless telegraphy, the heliagraph, balloon reconnaissance, and last but not least, telephotography, there cannot be any valid excuse for not having reliable data to act on,—except in some very unusual circumstances. Though the first three above mentioned methods of acquiring information are being utilised to a certain extent, our military authorities have hitherto entirely failed to see the great possibilities open to the use of a telephotographic equipment, more especially if employed from a balloon. Experiments, it may be admitted, were tried with light instruments by the Intelligence Department in England, as far back as 1892. But the telephoto camera was then it its infancy, and very defective, when compared with its present high power efficiency. This defectiveness, coupled with adverse atmospheric conditions prevailing at home, very naturally produced results that were in those days considered unsatisfactory. From that time up till quite recently, this highly scientific instrument has stood condemned by our War Office, regardless of the many extraordinary improvements that have been made in perfecting its powers by the great specialists in this branch of photography. But it does not seem to have occured to any one, that what may not suit the cloudy climate of England, might on the contrary produce most favorable results in countries, such as India, blessed with brilliant sunshine throughout the greater part of the year.

It will be advisable now to premise any further remarks on this subject, by briefly explaining what telephotography really means. The telephoto lens was first invented about nine years ago, and placed almost simultaneously on the market by Mr. T R. Dallmeyer in England, M. Duboseq in France, and Dr. Meithe in Germany; and since then there has been an increasing demand for these lenses, especially for purposes of long distance photography, and most of the continental nations have already adopted them for military purposes. The telephoto camera was first used in actual warfare, during the Chino-Japanese War of 1894; and some excellent telephotographs were taken by a Japanese officer in the naval engagement off the Yalu river in that year. One taken at a distance of over two miles, of the *Tie-yen*, one of the largest men-of-war in the Chinese navy, shows the vessel to be in a sinking condition, and the damage done by shot and shell is clearly discernible in the photographs. Our own War Office has, however, continued to look askance at this valuable instrument. But quite recently public pressure has compelled it to take up the subject; and we have lately heard that a solitary telephoto camera of small dimensions and low power has been despatched to South Africa. This diminutive instrument has been fitted to a bicycle. When it is considered that the other military powers are at present using large telephoto cameras of great power fitted to balloons, men-of-war, carts, etc., it will readily be conceded that we are not giving a fair and favorable trial to telephotography in the present war. To eschew all technical terms, in plain language, telephotography is simple the use of a special and variable long focus telescopic lens, optically adjusted to the lens of a good photographic camera. By this combination, photographs of objects a long distance off can be taken as if the operator was comparatively close to them. If, for example, the resulting picture by an ordinary camera of an object ten miles away, measured on paper, say one inch square, the same picture if taken with a telephoto lens, from the same spot, would measure 16, 32 or 64 inches square, and so on, according to the magnifying powers of the lens and the size of the camera used. It can now easily be realised what an enormous advantage such an instrument would confer on a general, either defending, or about to attack, a fortified position. The topographical configuration of the country, the direction of the entrenchments, the positions of the larger guns, the massing of the enemy, etc., would all be clarly depicted on a handy sheet of paper. This balloon telephotography, supplemented with a few taken along the horizon by the same means, would be simply invaluable from a military point of view. The photographic range of the telephoto camera may be considered as unlimited. Desireable telephotographs have been produced at a distance of over forty miles, but really valuable images on a large scale can always be taken with facility from distances beyond the reach of rifle and gun, that is, from two to ten miles. But as stated before, given a powerful lens and a clear atmosphere, the range of the telephoto camera will be found to be practically unlimited. There is yet another simple method, though not to be generally recommended, of taking enlarged long distance views by means of a series of ordinary stand cameras which is as follows: a camera is set up for instance and focussed on a rock, say a thousand yards away, another camera is then set up behind, and focussed on the ground glass of the first in such a manner as to enlarge the image of the rock. The focussing cloth is then thrown over the two cameras so as to span the intervening space, and exclude the sun. The ground glass of the first instrument is then removed, and the exposure made. The result is an enlarged picture of the rock, which will appear as though taken from quite close by. If a still larger magnification is required, it is only necessary to add one or more cameras to the first series. But for ease of manipulation, and clear definition, this latter method does not compare favorably with the enlarged direct picture, taken with a good telephoto camera.

The introduction of all new discoveries is generally followed by a good deal of adverse criticism; and the telephoto process has, it may well be imagined, not escaped those who make a point of objecting to everything new. For example, it has been stated that an ordinary telescope will show all that is necessary of distant objects; and that the reports and sketches of scouts in war will furnish all the information that can reasonably be required,—therefore why bother about telephotography? Again, it has been fallaciously urged that an ordinary photograph of a distant object, if enlarged afterwards, will give quite as good results, as a direct enlarged picture taken by a telephoto camera. These objections will now be dealt with, and shown to be quite untenable. To begin with the telescope: it will be at once conceded that a powerful telescope will of course show objects clearly and with very little trouble; but a general conducting a campaign cannot possible be everywhere with his telescope, even if he had not other important duties to perform. He must necessarily depend on the telescopic observations of others; and as it is a psychological fact that no two men have the faculty of describing the same thing exactly alike, the reports sent in by such observers would not leave so convincing an impression on a general's mind, as would be the case if such reports were supplemented with long distance large telephotographs of the points reported on. The same arguments hold good regarding the reports and rough sketches sent in by various scouts. It will, therefore, be seen that telephotography does not aim at altogether abolishing telescopes and military scouting, but puts forward its claim as being a very powerful adjunct to these means of military observation. Lastly, there is the plausible comparison made between ordinary subsequent enlargement of a long distance photograph, and the direct enlargement by telephotography. The following will show that the advantages lie wholly with the latter. As a preliminary it must be conceded, that the clearer the definition of details in a large photograph, the more valuable it will be for military purposes. Now, in making ordinary enlargements from small pictures, you must necessarily disperse the minute particles of color matter from the picture, and this immediately blurs the details and outlines; and the greater the magnification by this method, the greater must be the consequent blurring and indistinctness. Besides, some negatives on glass, or film, cannot be enlarged at all, owing to inherent defects; while even those that do lend themselves to this process can only be enlarged to a certain proportion, beyond that point the blurring is so great that the picture is practically destroyed. In small photographs, the chemical particles that form the details of the picture, coalesce to a certain extent, and show as black patches; these latter, if subsequently enlarged, only appear larger, but give little or no further distinctness of detail. Besides, whilst telephotography entails only one operation, ordinary enlarging is a double process; you first have to take your photograph, and then afterwards enlarge it by another apparatus. This means greater expense and trouble, and an appreciable loss of time, all of which are decided disadvantages in time of war, and lastly, if for any reason it was necessary to produce an enlargement, of say a fortified position, a better and much larger result could be procured from the already magnified telephoto, than from an ordinary small photograph. It will therefore be realized that there is absolutely everything in favor of direct long distance telephotography.

A few instances of practical application of telephotography in war will not be out of place here. In the navy, for example, specially constructed long-range instruments of superior power and rapidity could easily be utilised from men-of-war, to procure images of foreign coast defenses, from a greater distance than the ordinary three-mile limit, and on a sufficiently large scale to be of very high value, in the event of an attack or bombardment being contemplated. While, with our own land forces, the utility of the instruments would be still more marked. In the defense, for instance, telephotographs taken at every available opportunity of the enemy's positions, would clearly show the exact movements of the besiegers, and any fresh entrenchments, etc., that they may have thrown up over-night. Such exact information would undoubtedly be of great value to the defense in altering their own dispositions, and planning counter-attacks. On the other hand, the attack would benefit even to a greater extent. On the Tugela and Modder rivers, for example, had a series of telephotographs been taken, both by balloon and on the ground, of all the positions, our lines of attack could clearly have been laid down on these photographs with ordinary pen and ink, while every prominent point would also have had a number put on it for further guidance, and for reference to any subsequent orders that might be issued during the course of the battle. Copies of these marked photographs could then have been distributed among all the principal leaders, and the attack carried out with almost mathematical precision. Under such conditions there could be no possibility of confusion of orders, or misdirection of advance, such as have unfortunately so frequently occurred of late, both in our frontier and South African campaigns. Such instances of the great utility of telephotography might be multiplied indefinitely, but enough has been stated to show that this valuable adjunct to military observation can no longer be wisely ignored by forces. And, finally, it cannot be denied that all such telephotographs would undoubtedly furnish valuable records of the war to all future historians and military students.

There has been a certain amount of wild criticism in the press of late against telephotography, but the internal evidence goes to show that the adverse remarks have invariably been made by those who have had little or no personal acquaintance with the subject. The fact that these scientific instruments have now a recognised place in the armies and navies of all civilised powers ought to be sufficiently convincing that the telephoto camera has some real military value. This eminently practical branch of military photography can no longer be consistently ignored by us, and the Indian Government would be wise in losing no time in taking up the subject seriously. The gain to our army in the field would certainly be on a par with that conferred by the telegraph, the heliograph, and the radiograph, all of which are nowadays considered absolute necessities in every civilised army. The formation of a small special class for instructional purpose is strongly advised prrferably in the hills, from where trained telephotographists could be sent to every divisional command in India. Selected volunteers should also be encouraged to join this class; and there cannot be any doubt that many of the more advanced and practical volunteer corps would take up this interesting subject with the utmost enthusiasm. During peace-time much valuable work could be done in telephotographing the environments of our fortified posts throughout the country, as also the various strategic passes on our frontiers; while in the cold weather maneuvres, these instruments could either independently, or in conjunction with balloons, be extensively employed as valuable aids to the strategy and tactics of our army. We have lost much regrettable ground already as a military nation, by our tardiness in adopting the many modern, scientific adjuncts to warfare, and it is now devoutly hoped that the eminently useful telephoto will no longer be sacrificed to our old-world and unpractical conservatism in such matters of national importance as the high efficiency of our army.

—*Journal United Service Institution*, India, April 1900.

WARSHIPS AND TORPEDO BOATS.

The German Armored Cruiser Prinz Heinrich.

The *Prinz Heinrich*—at present completing for sea—is apparently intended as a standard type for German armored cruisers. Unlike the *Fürst Bismark*, she is not a merely weak battleship, but a cruiser pure and simple, built chiefly with an eye to cruiser work.

Her principal dimensions, etc., are as follows:

Displacement	8868 tons
Length	394 feet
Beam	65½ feet
Draught (mean)	23¾ feet
Armament	Two 9.4-inch (24 cm.)
"	Ten 6-inch (15 cm.)
"	Ten 1-pounders
"	Four Maxims
Torpedo tubes	One bow, submerged
" "	Two broadside, submerged
" "	One, stern, above water

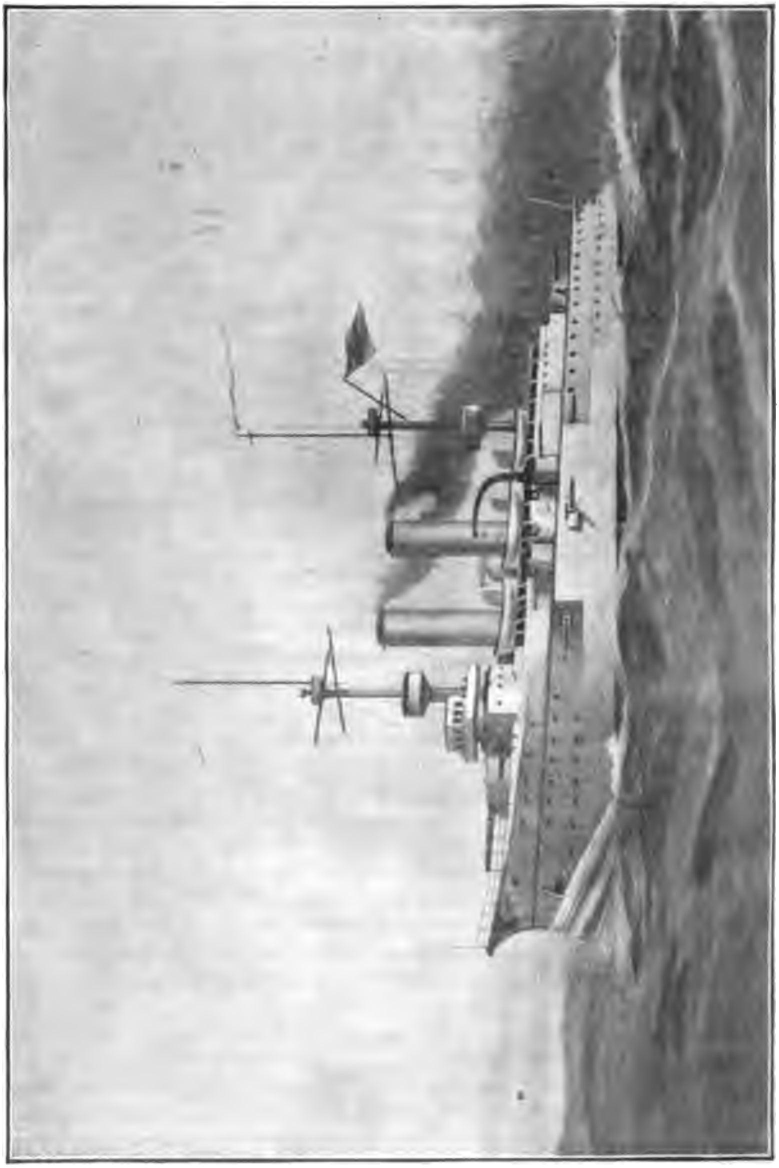
The armor is distributed as follows: There is complete water-line belt of Krupp armor 4 inches to 3 inches in thickness, reinforced by a protective deck 2¾ inches thick on the slopes. Above the belt there is a redoubt about 165 feet long, and of about the same thickness as the belt. Above this again is the main deck redoubt, 6 inches thick, in which six of the 6-inch guns are mounted. Both redoubts have 6 inches bulkhead, while screens will be placed between the guns in the upper one. On top of the upper redoubts there will be four turrets, oval in shape, each 6 inches thick, and carrying a 6-inch gun. Forward and aft are barbettes, each mounting a single 9.4-inch gun, and protected by stout shields. These barbettes will have a total height of about 9 feet, will be 6 inches thick, with armored hoist descending to the protective deck. The conning tower, which will have a thickness of 6 inches or more, will have an armored tube of communication.

It will be noted that the *Prinz Heinrich* has little in common with the *Fürst Bismark*. The latter has no protection to the lower deck, and has her armament a good deal more distributed. The *Prinz Heinrich*, on the other hand is a direct adaption of the French *Brennus*, and closely resembles that ship both in the disposition of armament and in the system of armoring. The high forecastle and the bow submerged tube are the only distinctly German features in the design, and there is nothing of the *Fürst Bismark* about her save in general outline.

Like all German ships, the *Prinz Heinrich* will have no wood used in her construction, unless the latest discovery, or supposed discovery, that woodless ships are very insanitary, causes some departure from a well-established German custom.

The estimated indicated horse-power is 15,000, which is expected to give a speed of 20 knots. There are three screws, and the dead-wood aft is very much cut away after the *Elswick* model, in order to make the ship relatively handy. This, for a cruiser, she should be, as she has a very fair proportion of beam to length. The boilers selected for her are of the *Dürr* type.

Comparisons between the *Prinz Heinrich* and other vessels like her in size and *métier*—the *Bayan* and the British *Essex* class—we defer till we have treated this last; but it may be of some interest to compare the *Prinz Heinrich* of 1900 with the *Edgar* class of 1890 and the *Orlando* of 1886, since the armaments in each case are practically identical, though the German 9.4-inch gun is, of course, a far more powerful gun than the old 9.2-inch in the other ships. This, however, is more an accident of date than anything else, and

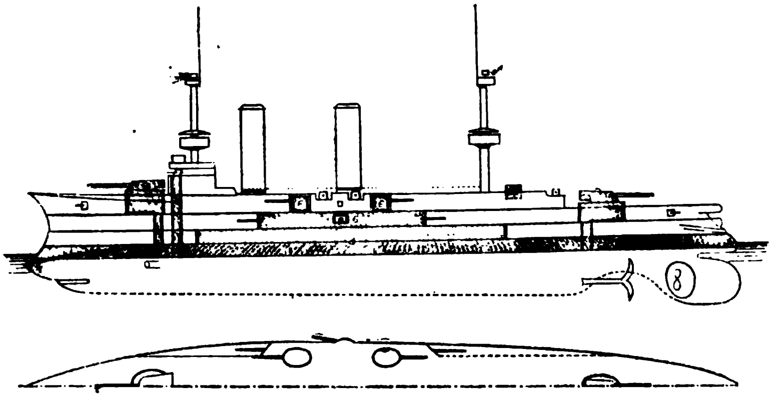


German Armored Cruiser *Prinz Heinrich.*

in so far as the modern guns are all heavier, enforces rather than detracts from the point we wish to make—the difference between what was demanded then and now for a ship carrying a more or less standard for a first cruiser in the way of protection and speed.

	Orlando.	*Edgar.*	*Blake.*	*P. Heinrich.*
Date of launch	1886	1890	1891	1890
Displacement, tons	5700	7700	9000	8868
Length, feet	300	360	375	394
Beam, feet	55	60	65	65¾
Draught, feet	26	26	27½	24¾ (mean)
Armor belt	10	Nil	Nil	4
Do., lower deck, inches	Nil	Nil	Nil	4
Do., battery, Q. F., inches	Nil	6-in. on 4 guns	6-in. on 4 guns	6
Do., big guns, inches	4½ in. shields	4½ in. shields	4½ in. shields	6
Do., deck, inches	3	5	5	2½
I. H. P. *circa*	9000	10,000 to 12,000	20,000	15,000
Speed, trial	18.5 to 19	19.5 to 20	21.5	20 (est.)
Actual sea-speed at a push	15.5 or less	19.5	20.5	–

The *Orlando*, the only cruiser carrying belt armor except the *Prinz Heinrich*, has less than this ship, and is altogether smaller. She belongs to the era of "paper" ships, and to this day, with her 10 inches "armor belt"—all under the water-line, by the way—and heavy armament, is a grand ship for the makers of statistics. The *Prinz Heinrich* could probably tackle three of her. The *Edgar* and *Blake* are more interesting comparisons. All the class are as good ships as ever were built for speed. Although now nearly ten years old, they are all excellent steamers, and in the recent maneuvers kept station at 19 knots without the least difficulty. Ten years have seen far less advance in speed than people are prone to imagine. It is exceedingly doubtful whether there is a warship in the world that could beat the *Edgar* class in a thirty hours' race. The advance of recent years has been in protection, and the problem to-day is to pile on armor without deteriorating the other cruiser essentials. Of course the difference has to be made up somehow. In the case of the *Prinz Heinrich* coal is probably sacrificed—though, as her capacity has not yet been announced, it is difficult to speak definitely on this point. The greatest point of divergence, however, tends to be in form, and owing to changed lines more speed is got out of a unit of horse-power to-day than in



SKETCH, ELEVATION, AND PLAN OF PRINZ HEINRICH the past. Still this embraces a wide subject hardly to be discussed in this article, the matter being very complicated. As regards its practical results, mere dimensions of the ordinary sort do not go for much. Though the modern cruiser is, as a general rule, longer and proportionately narrower than her predecessor, we now and again find some of the best steamers short, broad ships, comparatively speaking. Of modern cruisers of moderate size nothing in the British Navy has beaten the *Vindictive* class, and these are only 320 feet long, with a breadth of 57½ feet—dimensions very equivalent to those of the *Orlando* class, displacement and horse-power being also fairly akin. Yet in the one case the ships never could steam fast, while in the other 19 knots is easily maintained at sea in moderately smooth water. Under-water lines and arrangement of weights—both things too elusive for statistics—are, of course, far and away the principal governing factors in these instances.

However, length is the thing that tells directly the sea gets up, and in a seaway the *Prinz Heinrich* ought to beat any of the older vessels with which we have compared her, about 400 feet being the necessary minimum of length for any cruiser to maintain speed in big waves. If she is much less than 400 feet long she will be going up and down on small waves, and lose speed accordingly. This fact—that ships cannot maintain speed unless long, coupled with the fact that they cannot steer properly unless relatively short—is one of the worst problems that faces the designers of warships. They cannot eat their cake and have it too; hence much variety and the eternal compromise. But since the present trend of ideas is that a speed-keeping cruiser is better than a handy one, more or less long vessels are now the order of the day. Ten years hence the "agile" cruiser may be in favor again, but at the present time cruisers maneuvre about as adroitly as elephants.

—*The Engineer*, September 21, 1900.

BOOK REVIEWS.

With Seven Generals in the Boer War. A Personal Narrative by Major A. W. A. Pollock, late the Prince Albert's Somersetshire Light Infantry, and a Special Correspondent of the "Times" in the Boer War. With illustrations, maps and plans. London: Skeffington and Son, 163 Piccadilly. 1900. Pp. 292. 6 Shillings.

Major Pollock presents in this interesting volume his personal experiences in the Boer war, which he followed under particularly favorable circumstances as a special correspondent of the London *Times*. He entered upon his duties well equipped for the work, and his criticisms of the tactics and strategy of the campaign are consequently of great value. The latter relate more especially to the disaster at Stormberg, the operations south of the Orange River (about which the information in other accounts is very meager), the advance from the Modder River to Bloemfontein, and the relief of Mafeking.

The Stormberg disaster is graphically described and is most interesting reading. After discussing the causes of failure the author concludes in these striking words:

"Defeat in such circumstances was the natural consequence. The only marvel is that the force escaped annihilation; certainly but for the good work done by the artillery and by the mounted troops, not one man could have reached Molteno, although the shooting of the Boer riflemen was contemptible in the extreme. Worse shooting in action than that of the Boers in the Stormberg engagement has, perhaps, never been seen in war. Moreover, the failure of the enemy to make any determined attempt to cut off the straggling procession of worn-out troops denotes either strange want of confidence or incompetence."

After a very full and detailed account of Stormberg, the author takes up De Montmorency's operations around Dordrecht, which were evidently conducted with great skill and judgment, and are related with much satisfaction and a high appreciation of this commander of scouts.

We are next presented with a glimpse of Rensburg under Major-General Clements, which involves some very interesting and exciting incidents told in a very happy way.

The scene now shifts to the Modder River, whither the author had been sent, but he reached Roberts' army, only in time to witness Poplar Grove fight. The latter, however, is described in forcible language, and the author is not at all uncertain in his criticism of the cavalry, which failed to push on to the position it had been ordered to seize.

"Had General French reached his intended destination, the Boer army must have shared the fate of Cronje."

After Abrahams Kraal Major Powell spent some time with Lord Methuen in his operations about Boshof, and then accompanied Mahon's relief column to Mafeking.

Being a narrative of personal experiences the work is interspersed with many amusing as well as instructive incidents and observations.

The author's former experience as an officer of the army, his present position as a war correspondent, and his knowledge of tactics enabled him to judge correctly and to state his views fearlessly on the various actions he witnessed. Indeed, these are the leading elements in the work, the points by which it is characterized.

The volume is illustrated by reproductions of photographs and by a series of most excellent maps, the latter far better than any thus far published.

The character of the country, the life of the soldier, the personal and professional qualities of the seven great generals in the southern and western theatres, and the characteristics of the various arms of the service, as well as the tactics on both sides,—all these are well set forth in Major Pollock's entertaining narrative. The personal element adds a charm which is absent in a calm impersonal account, moreover, it confers a feeling of reality in the actions and sympathy with the events which makes the movements in battle seem less mechanical. The author's experiences hold the reader's attention and interest, and make the reading a pleasure rather than a task. We follow his adventures with a lively interest in himself, his horse, his servant and all his belongings, and at the end are as sorry to part with them as we are with the characters in a good novel. J. P. W.

The War in South Africa: a narrative of the Anglo-Boer War from the beginning of hostilitles to the fall of Pretoria. Captain A. T. Mahan. New York: R. H. Russell, Publisher.

Captain Mahan's history of the war South Africa is a handsome volume beautifully and bounteously illustrated, not only with cuts scattered throughout the text, but also with many full page illustrations in color by well known artists (Remington, Klepper, Hering, Reuterdahl, Thurlstrup, Wenzell, and others), and a few maps.

The subject is treated rather as philosophy of history than history simply, or tactical or strategical study. The author evidentiy has a strong leaning to the side of the British, and gives only the British side not only of the causes that led to the war, but also of all the episodes of the fierce struggle. He quotes freely from the official despatches, and has not been led astray by any false reports or temporary misunderstandings of the situation, as were some of the historians of the war.

The account, because of its philosophic and reflective tendencies, is good reading for the general reader, and the student of the art of war will find considerable material for his consideration, although the work is not strictly a tactical or strategical study.

The book has an exceedingly interesting introduction by Sir John G. Bourinot, Clerk of the Canadian House of Commons.

The history ends with Lord Roberts' entry into Pretoria, and does not enter into the later actions following that long march with which all larger movements of the two armies terminated.

On the whole this work of Captain Mahan's from a philosophic and artistic point of view is a splendid achievement, but from a tactical or strategic point of view it is unsatisfactory, partly because the author could hardly be expected to be properly equipped for such study, and partly because he evidently wrote under pressure of other work, and without the years of thought and attention he gave to his greater work on Lord Nelson or Sea Power.

J. P. W.

Kriegsgeschichtliche Beispiele des Festungskrieges aus dem deutsch-französischen Kriege von 1870-71. Von Frobenius, Oberstleutnant a. D. Viertes Heft. Berlin: E. S. Mittler and Sohn. 1900. 2.50 marks.

This, the fourth number of a series of studies on the attack and defense of fortifications in the war of 1870, comprises the first part of the artillery attack, viz: bombardment, which is illustrated by Verdun, Toul and other forts.

The first section treats of the attack with such means only as the field army carries with it, and is subdivided into the examples of Verdun, Toul, Bitsch, Pfalsburg, Montmédy, Neubreisach, Péronne, Lichtenberg, Marsal, Rocroy. Other sections are to follow in succeeding parts.

In view of the fact that the great value and power of modern field artillery, so little appreciated in 1866, were here in this war for the first time manifested, make this work a particularly valuable study for military men.

The events are set forth with great clearness and in full detail, and not the least valuable portions are the author's comments. The work is illustrated by plans of Verdun, Toul, Montmédy and Péronne.

It is distinctly a *tactical* study, and as such appeals directly to the military student, who desires to utilize in future wars the experiences of the past. The lessons to be learned are set forth by an expert in this branch of the art of war, and one experienced in actual war practice, and are all very clear and simple.

Like other tactical-historical studies by Germany's military authorities, this is unique on the subject it covers, and we know of no better study for the officers of any army than works of this scope and character. J. P. W.

Descriptive General Chemistry. A Text-book for Short Course. S. E. Tillman, Professor of Chemistry, Mineralogy and Geology, United States Military Academy. Second Edition. New York: John Wiley and Sons. 1899.

The first edition of this work was reviewed in the *Journal U. S. Artillery* a year or two ago, and what we then said holds true at present.

Having been ourselves associated with the Professor as his assistant for some twelve years we naturally feel a special interest in this result of his long experience as a teacher, particularly as we used all our influence to persuade him to add "another to the already long list of chemical text-books." We discussed every text-book that promised to be useful, but always found them wanting in some particular that seemed essential. Finally, when graduate after graduate, returning to the Academy, spoke of the necessity of a special text-book for the short course at the military academy, he was persuaded to write it.

We cannot do better, in our review of his work, than quote from the *Preface*, which sets forth clearly the author's purpose in writing tho book, as well as the scope of his work:

"Chemical instruction has been given at the Military Academy for nearly eighty years. The experience and judgment of the Academic Board (Faculty) and of their military superiors has from the outset limited this instruction to a very short course, the time now devoted to it being about two months, and this has been substantially the same for many years. The actual time of the student available is a little less than two hundred hours for instruction, study, and other work in the subject.

"The problem and effort of this department has ever been to provide the most appropriate instruction in this short course for students who are to become professional soldiers, and who approach the science well disciplined in habits of study and well grounded in the ordinary mathematical processes. It is thought that a great majority of those who have had experience in chemical teaching will agree that the unique disciplinary training for which chemistry is so admirably adapted as a laboratory science could be only very imperfectly attained under the conditions.

"It has generally been the conclusion of those charged with this instruction at the Academy in the past that the laboratory method alone, or mainly, in so short a course, could not be made of as much value to the pupils as the method making the *acquisition of knowledge* the essential feature, and that the best results could be reached through careful study of the proper text, well-conducted recitations, accompanied by experimental and explanatory lectures. While accepting the general correctness of this conclusion of the past, the author would add a small amount of well-selected laboratory practice on the part of the student, this practice being intended as much for sustaining and increasing interest in study and for fixing principles in mind as for strictly laboratory discipline.

"The information given should be that most useful, improving, and gratifying to educated men. The decision as to that which is most beneficial and desirable for military students has been made through the assistance and suggestion of many officers who have acted as instructors in the department, after experience in the different arms of the military service. In the opinion of the author, however, the chemical knowledge most requisite to the average professional soldier differs but little from that essential to other educated men.

"While it is desirable, under the conditions, to give the educational element of *information* great prominence, it is advocated that, by the proper system and sequence, the acquisition of the knowledge can be made to involve a high order of mental training; indeed, in a science so comprehensive, involving so many facts and such a variety of useful applications, the one cannot be remembered nor the other comprehended except through scientific method of great disciplinary value.

"In the efforts to best meet the imposed requirements and conditions no single text-book has been found entirely suitable, though many have been carefully examined and tested. Some books contain substantially all the desired matter, but usually much other that cannot be used. The lack of the desired arrangement of the matter is another important difficulty to be overcome. In all chemical text-books used at the Academy many omissions, insertions, and transpositions have been found necessary. The necessity for such changes adds greatly to the difficulties of the student in accomplishing what is expected from him.

"This book has been prepared to embody the substance and arrangement of a short chemical course for the *general* student. It aims to give a concise statement of the more fundamental principles of chemistry, together with that class of chemical information most essential to cultured men, and which will enable them to comprehend many ordinary natural phenomena as well as to understand the more important applications of the science which are now so frequently met with. The book is not fitted nor intended for laboratory guidance.

"The arrangement adopted in the book is that which long experience and careful consideration have shown to accomplish the best results with students equipped as ours are, in the time available."

The complete work is an excellent text-book, containing as it does not only the essential principles of chemistry and the chemistry of the more important elements, but also the most recent of the world's great chemical processes in manufacture, arts and science.

We have ourselves been interested in the subject of chemistry for over thirty years, and are familiar with nearly all the best works in English, French and German, and can confidently say that, for a short course, and for mental training and useful information on subjects in this science that every educated gentleman should be familiar with, Professor Tillman's work stands unrivalled. This opinion is not the mere result of one of our pleasantest associations in life, but is based on a careful study of the work before us. J. P. W.

A Text-book of Important Minerals and Rocks. With Tables for the Determination of Minerals. S. E. Tillman, Professor of Chemistry, Mineralogy and Geology, U. S. Military Academy, West Point, N. Y. First Edition. New York: John Wiley and Sons. 1900.

In this his latest published work Professor Tillman has made another valuable addition to the text-books designed for short courses and general (rather than special and technical) training in the important sciences.

The generality of books on this subject, in attempting to cover the entire field, produce volumes too complicated for practical use and bewildering to the average student; moreover, much difficulty is experienced in their use in distinguishing the important from the unimportant. In the work before us the latter has been done by one who has had long experience not only in the section and lecture rooms and in mineralogical and geological cabinets, but also in the field, where he spent several years on the government survey work west of the 100th meridian, associated with well-known mineralogists and geologists.

The present volume is the result of years of experience, and embodies what has been found best suited to the requirements of the military academy, bnt should also be most useful in any short general course.

The tables, for which the author gives *us* such generous credit, were prepared under his direction and supervision, and with his constant assistance and criticism. In their original form they were the direct result of our experience at the Royal School of Mines in Freiberg, Saxony, where Professor Weisbach held his interesting *Praktikums*. They were modified and improved as time went on by the Professor and his assistants.

The three works that the Professor has given to the world (Heat, Chemistry and Mineralogy) are not only important and valuable additions to the text-books on these subjects, but have each a distinct, definite and sufficient reason for existence, and are a credit to the institution he represents.

They were not written (as text-books sometimes are) from a mere desire to write, but we can testify from personal knowledge that the necessity for their appearance was forced upon the author after years of resistance in each case, and after making every effort to adapt the text-books already in existence to the needs of his department. J. P. W.

The Times History of The War in South Africa, 1899-1900. Edited by L. S. Amery, Fellow of All Souls. 5 Volumes, $25.00. Sold only in Sets. Volume I. Pp. 392. London: Sampson Low, Marston and Company, Ltd. Imported by Charles Scribner's Sons, New York.

This magnificent history of the great struggle between the British and the Boers is a splendid achievement in every way,—politically, historically and artistically. The world in general is particulary interested in the political situation of which the war was the outcome, and even for military men a knowledge thereof is essential for a complete understanding of the military operations. It is very gratifying to the great majority of readers, therefore, to find the entire first volume of this series devoted to presenting the circumstances which led up to the war, especially as no adequate connected account thereof has as yet appeared.

The introductory chapter discusses the political importance of the war, compares it with the Crimean War and the Indian Mutiny, and with the American Civil War, and then presents the views of both parties and the causes of the war.

To American readers the comparison with our Civil War is most interesting and remarkably clever, and the analogy is nothing short of surprising.

"The South African Civil War is separated by more than sixty years from the Great Trek, the South African counterpart of the Secession. But even taking into comparison the situation in South Africa only for the years immediately preceding the war, it is not difficult to trace a most interesting analogy with the situation in America before 1861. In both cases the issue was a double one, or rather presented itself in two different aspects. The question of the black man's right to personal liberty in the Southern States, or of the white man's to political power in the Transvaal, was in each case inextricably interwoven with the wider question of the maintenance of Federal or Imperial supremacy—the words stand for the same political idea—against the assertion of State rights or Republican independence."

Uncle Tom's Cabin finds its counterpart in *The Transvaal from Within*, and John Brown's Raid into Virginia in Dr. Jameson's Raid.

"Every endeavor was made in the South to foist the odium of the conspiracy upon men like Seward, Sumner and Chase, just as every endeavour has been made by the Krüger party in South Africa since the Raid to foist the responsibility of it upon Mr. Chamberlain and the British Government."

The attitude of Horace Greely and his party has its parallel in that of the Englishmen, who declared that the Uitlander grievances had to be remedied, but the Imperial Government ought to make clear its intention of applying pressure to the Transvaal only to tne ultimatum point and no further.

"The resemblance between the course of military operations in America and in South Africa is no less close than the resemblance between the political situations. The North, like England, began with a wholly unwarranted contempt of its opponent; and, like England, the North found that it had to put forth exertions never dreamt of before in order to see the war through. The blunders of British generals before abler men came to the front, the initial defeats, the superior mobility of the Boers, their good shooting, their skill in taking cover, all find their parallels in the American war."

These are a few of the more prominent points of resemblance brought out by the author, but the entire chapter is well deserving our most careful study and consideration.

The three succeeding chapters contain a detailed history of the Boers from 1815 to 1891, together with a full account of President Krügers policy, especially from 1881 to 1891.

The fifth and sixth chapters, dealing with the grievances of the Uitlanders and the struggle for political supremacy, are mainly the work of Miss Flora Shaw. The seventh chapter is again the work of the editor himself, and treats of the Jameson Raid. The eighth chapter, on the relations of the

Imperial Government with the Transvaal in the years following the Raid, is from the pen of an anonymous author. The ninth chapter, describing the movement in Johannesburg which immediately led to Imperial intervention is by Mr. W. F. Monypenny, who was at the time in Johannesburg as editor of the *Star* and correspondent of *The Times*. The rest of the volume is by the editor himself. He had the assistance and advice of such men as Mr. J. G. Fraser of Bloemfontein, through whom he obtained access to the minutes of the secret conferences held in 1887, Mr. Fitz Patrick, who wrote *Transvaal from Within*, Colonel Frank Rhodes and Mr. J. W. Wessels, finally, he had the good fortune to be himself in Pretoria or with General Joubert's force at Sandspruit during the last three weeks preceding the outbreak of the war.

The editor was also fortunate in having for reference the recently published important work of Mr. J. F. van Oordt, entitled *Paul Krüger, and the Rise of the South African Republic*, which, as he himself states, not only contains many valuable details for the period from 1881–1897 gathered from Transvaal official sources, which have not appeared elsewhere, but also gives by far the clearest and most convincing exposition of the Krüger-Leyds policy from the point of view of a fanatical partizan.

The parts of greatest interest to the general reader are, of course, those discussing the events immediately preceding the outbreak of war, although it is impossible to understand these clearly without some previous knowledge of the movements that brought about the necessity for intervention.

This portion of the volume contains all the official correspondence on the subject, and is consequently of greatest interest, since many of the despatches have not until recently been made public. The reader cannot fail to be impressed with the patience and sincerity of the British, the insincerity of the Boers, and the vacillation of President Steyn.

"The grounds on which Sir A. Milner based his demand for intervention were the broad grounds of justice, of national honour, and of national self-interest. The treatment of British subjects in the Transvaal was a violation of the rights that every freeman claims in a new country which he has contributed to make, as well as the infraction of the whole spirit of the Conventions. It was on these grounds—grounds that would have been equally applicable in any other part of the world and against any other State, whether bound to us by special agreement or not—that he appealed to the British nation to make the case of the Uitlanders their own, and not on any technical violation of the terms of the Convention."

The entire correspondence and the actions of the British officials make it perfectly clear that the war was not waged in the interest of capitalists, but for the maintenance of a high principle.

The editor himself regrets that he finds it impossible to fully present the Boer side of the controversy, but any unbiassed reader will admit that he is remarkably free from all unfounded prejudice, gives the Boers credit for their strength and their virtues, and does not hesitate to express his admiration for the resistance they have made and for the sterling qualities of their rugged President.

This, the opening volume of a grand work, is and will remain the world's standard authority on the subject. The language of the author is clear and to the point, simple where simplicity is most essential, convincing where argument is needed, fascinating where description (of historical scenes or character qualities) comes into play.

The volume is beautifully dressed: printed in large type on heavy paper, bound artistically, and illustrated with many photogravure and other portraits. The map of South Africa accompanying this volume is one specially prepared for this work, and comprises the entire country from Cape Town on the south to Buluwayo on the north, and from Lorenzo Marquaz on the east to the mouth of the Orange River on the west, to a scale of 40 miles to the inch; in one corner is a map of Africa, and in another (for comparison of distances and area) a map of Wales (about equal in area to New Jersey).

The entire work promises to be one of the most important contributions to political and military history of our times. J. P. W.

Photographic Album of Aldershot Town and Camp, the Headquarters of the British Army. London and Aldershot: Gale and Polden, Ltd. Price One Shilling.

The great British camp of instruction, Aldershot, was first established before the Crimean War, and has been growing in importance ever since, till today it is well known all the world over.

The photographs here presented give a graphic picture not only of the place and its surroundings, but also of the soldier's life there and the military work going on. J. P. W.

Soldiers' Training and Other Notes. Major H. de B. Hovell. London and Aldershot: Gale and Polden. Price Two Shillings.

This little hand-book was written partly before the Boer War and partly from experience before the enemy. It contains many useful hints on the use of cover, entrenching, scouting, orientation, signalling and other subjects essential for acquiring self-reliance in the field, perhaps the most generally valuable quality of the soldier today. J. P. W.

Skirmishing Made Easy. Major B. Witherby. London and Aldershot: Gale and Polden Ltd. Price Six Pence.

This booklet of some fifty small pages is the result of the author's experience in the field in South Africa, and although, as the author himself states, it contains nothing essentially new, still his system of instruction embodies original ideas well worthy of consideration.

It is a clear and sensible presentation of a subject of vital importance to the army, and should be very useful in training men for field service.

J. P. W.

How to Keep "Fit," or the Soldiers' Guide to Health, in Field, Camp and Quarters, compiled by Surg.-Capt. H. Waite, V. M. S. Aldershot: Gale and Polden. Price Three Pence.

A small but useful little pocket volume, which should be in the hands of every soldier.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Notre Armée. Commandant Emile Manceau, Laurat de l'Institut. Paris: Bibliotheque-Charpentier. 1901. Pp. 425. 3 francs, 50 centimes.

An Exposition Booklet. Another beautiful production from the Bureau of Publicity of the Pan-American at Buffalo. Here comes another of the beautiful booklets from the Bureau of Publicity of the Pan-American Exposition, Buffalo, N. Y. It consists of 16 pages and a cover in light green. The unique feature of it is the miniature reproduction of the famous poster, "The Spirit of Niagara," which has had a most remarkable demand. The booklet is a popular picture book, the first page having an engraving of the magnificent Electric Tower, which is 391 feet high, and which will form the glorious center-piece of the great Exposition. On the same page is a miniature of one of the torch bearers which will adorn the wings of the Electric Tower, and beside it a picture of Niagara Falls. The second page shows a picture of the Electricity Building and five other small illustrations of the uses of electricity. The third page shows the splendid group of buildings erected by the National Government and which will contain the Government exhibits, also five miniature illustrations, one of them showing the life-saving station, where exhibitions will be given daily by a picked crew of ten men, during the Exposition. The fourth page is devoted to the wonderful displays of government ordnance; the fifth to the Machinery and Transportation Building and four other illustrations of modern machines and vehicles. The center of the booklet shows a birdseye view of the Exposition, and gives some idea of the great extent of the enterprise upon which about $10,000,000 is being expended. The grounds contain 350 acres, being half a mile wide, and a mile and a quarter long. Other pages show horticulture, graphic arts and mines, manufactures and liberal arts, the Music Temple, the Plaza and its beaufiful surroundings, the Stadium or athletic field, the agricultural, live stock and ethnology features, and a few of the 30 or 40 ingenious and novel exhibits which promise to make the Midway the most wonderful that has ever been prepared for Exposition visitors. The last page shows a ground plan of the Exposition, whereon the location of different buildings is indicated. The railroads will make low rates from all parts of the country during the Exposition, which opens May 1 and continues six months, and the people of Buffalo are preparing to entertain comfortably the millions who will attend. Anyone desiring a copy of this booklet may have it free by addressing the Pan-American Bureau of Publicity.

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The English mounted infantry in South Africa.—**M. Gids.**, 1.

Notes on the Evolution of Cavalry.—**Unit. Serv. Mag.**, February.

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FIRE CONTROL AND FIRE DIRECTION.

My purpose in this paper, is to consider the entire subject in practical dètail, and not merely to discuss the question as a scientific problem.

A thorough consideration of the subject, involves, first the method of instruction of the enlisted man; the details of the work at the gun; in the B. C. Station; and finally the general subject of Fire Control.

The Drill Regulations for Coast Artillery, while based upon a most excellent system, are in many respects exceedingly faulty. In several places the principles enunciated are unsound in theory; and we find regulations prescribed which are impractible. One of the chief difficulties to my mind, is the fact that the system is not clearly and exactly stated, and that it requires careful study to ascertain what is intended. One of the most valuable conceptions contained in the system, which simplifies the work of instruction in a most remarkable manner, is not even stated at all, and can only be ascertained by reading between the lines. I refer to the method of designating the various conditions for which corrections must be made, by the signs plus or minus, upon a fixed principle. We also find false terminology which is confusing to the enlisted men.

As an important example of the latter error, let us consider the graphic table headed δ_1/δ Factors (see Plate XII). We instruct our men to enter this Table with the Barometer and Thermometer as arguments, by means of which they obtain certain numbers -2 or $+3$, which they naturally believe to be the factors mentioned, and which is also true. Now having explained to them what δ and δ_1 represent, they will call your attention to the fact that when we have Barometer 30″ and Thermometer 60°, $\delta_1 = \delta$ and therefore that $\delta_1 / \delta = 1$, but the factor in the table for these conditions is zero.

In Table III, Ingalls Handbook, they find that with Barometer

30″ and Thermometer 70° the factor $\delta_1/\delta = 1.02$, but by the Graphic Table it is -2, this is confusing. If you explain to them that the 2 in the Graphic Table means two per cent., they will probably say yes, but by Ingalls it is 2% greater than unity, why do they use the minus sign. Of course, this is partially due to the error in writing δ_1/δ instead of δ/δ_1; it, however, requires a mathematical demonstration to explain it satisfactorily, which will rarely be understood.

This would all have been avoided by heading the table as follows: *Table for determining the relative weight of air, and by affixing the sign of % to each of the numbered diagonal lines.* The soldier would then readily understand, that -2% meant that the air was 2% lighter than the normal; and that $+2$% meant that it was 2% heavier than the normal.

If now we compare this with the first column of the B. C. Table, we find it headed range correction for .01 δ_1/δ; more confusion, what does this mean? How much simpler it would have been to have headed this column: *Range correction for 1% change of weight of air.* It would have then followed as a matter of course, that if the air was 2% light they must correct this range by subtracting twice the allowance for 1% change of weight of air.

The use of the + and the — sign in this table, together with its use on the wind dial (see Plate XI, Fig. 1) are the most conspicuous places where the plus and minus system is indicated; nowhere in the book is it distinctly set forth.

The principle may be stated as follows:

Any condition which requires an additive correction to be made is called a *plus condition;* and any condition which requires a subtractive correction to be made is called a *minus condition.*

Thus:

When the air is heavier than the normal it is called a....... + Air.
When the air is lighter than the normal it is called a.......... — Air.
When the tide is higher than mean low water it is called a + Tide.
When the tide is lower than mean low water it is called a — Tide.
A wind component from the front is called a + Accelerating wind.
A wind component from the rear is called a — Accelerating wind.
A wind component from the right is called a + Deviating wind.
A wind component from the left is called a — Deviating wind.

All the soldier needs to be taught is that he adds for a plus condition and subtracts for a minus condition.

The above system works absolutely for laying by Case III. When using Case I or II the following must be added.

Allowances taken to the right on a sight are plus. Allowances taken to the left on a sight are minus. Always take plus points for a plus deviation wind or condition, and minus points for a minus deviation wind or condition.

Drift is always minus whether allowed for on the azimuth circle, or in points on the sight.

In the B. C. Station the computor obtains his air factor in the terms of + or — from Table XII. His height of tide as + or —, and from the wind dial his wind component in terms of + or —. He therefore adds and subtracts according to the sign, without stopping to reason the question out.

This system is of immense practical value; yet it is nowhere fully set forth in the Drill Regulations, and on several occasions when I have called officers' attention to it, they have expressed surprise that they had not noticed it before.

Men should always be taught to think and speak of such conditions by the sign.

Example of question.

Question.—What is the ballicstic value of a 1 o'clock wind.

Answer.—½ plus accelerating and ⅞ plus deviating.

Question.—What is the ballistic value of a 11 o'clok wind 16 miles per hour.

Answer.—8 miles plus accelerating and 14 miles minus deviating.

It will be noted that I do not use the term COMPONENT, this is a mathematical term which men do not readily grasp, and I have found that they do seem to comprehend the idea of the ballistic value of the wind.

These conceptions can easily be memorized.

Thus when the air weighs more than the normal it is plus, and when it weighs less it is minus; this is the natural meaning of the signs. The same is true for tide conditions.

For wind and wind corrections, we have the convention: all corrections and conditions to or from the front are plus, all to or from the rear minus. To or from the right plus, and to or from the left minus. A plus correction is made for a plus condition and vice versa.

The only case where the natural order is reversed, is where the actual muzzle velocity does not agree with the tabular. In this case when the actual velocity is less than the tabular, it would naturally be looked upon as a minus condition; it is, however, a plus condition, as we must add in order to correct.

The actual problem with which the Range Finder Detail have to deal, may be exemplified by the following example.

Barometer 29″ 5. Thermometer 70°.
Tide, + 4 feet.
Accelerating wind, — 16 miles per hour.
Deviating wind, + 8 miles per hour.
Range from gun 6000 yards. Azimuth from gun 210° 14′.

From which must be computed the corrected range and azimuth for the directing gun, to be sent to the battery.

If a member of the R. F. Detail can solve such a problem promptly and accurately, it is all the mathematics and ballistics that it is necessary for him to know.

The Gun Commander and Gunner must each be able to accurately use his difference chart, and lay his gun.

In my opinion gunners should be graded upon the following basis:

A First Class Gunner should know his drill, his practical use of artillery instruments, be proficient in cordage, in the service and care of gun, carriage and ammunition, use of difference chart, sight and quadrant, and be able to give correctly the usual artillery definitions, and general nomenclature of piece and carriage.

The Range Finder Specialist, should in addition to being a First Class Gunner be able to adjust and use the Range Finder, and all the apparatus in the B. C. Station. To read all tables, to understand and use the Platting Board, and to be able to rapidly and accurately solve such problems as have been given above.

This is all the instruction that is needed, and any attempt to give further ballistic instruction, merely tends to confuse, and does not add to this efficiency of the artillery soldier.

The great desideratum in the B. C. Station, is rapid and accurate computation.

The chief difficulty met with in the use of the B. C. Table is error in multiplication. The multiplication process takes time, and generally interferes with accurate and rapid computation. This difficulty is easily avoided by constructing a correction table. In this table the correction for each per cent of air, foot of tide, drift and mile of wind, is entered up to ten units, and after that for each additional ten units, as far as may be necessary. These data are computed to the nearest yard or minute.

The only arithmetical operation necessary in using this table is addition.

Thus if you wish to determine the correction for a 24 mile accelerating wind, you add the allowance for a 4 mile wind to that for a 20 mile wind, both of which allowances are read directly from the table. And in a similar manner for any other data. Experience has shown that with such a table the corrected range and azimuth can be readily computed in 20 seconds.

While on duty as a member of the Gunners Board for the Fifth Artillery, I found that there was considerable misunderstanding as to the use of the telescopic sight.

Any arrangement of the sights of a gun, which throws the muzzle of the gun to the right while aiming, is an allowance to the right (points right or plus); any arrangement which carries the muzzle to the left is an allowance left (points left or minus). The moving of the rear sight to the right gives an allowance to the right; the moving of the front sight to the right gives an allowance to the left. In a telescopic sight the cross hair is the front sight, the eye piece being the rear sight; therefore to take points right, the cross hair must be moved to the left or vice versa. A simple rule which will work with all of our sights, open or telescopic, is that when the zero is to the right of the index, the allowance is right, and vice versa. In the telescopic sight the cross hair is the index. The new telescopic sights are all marked so that there can be no mistake in the matter.

The next important question to consider, is the method of predicting the position of a moving vessel.

The system prescribed on page 106 and 107, Drill Regulations Coast Artillery, assumes that it is possible to obtain a "rate of change of azimuth" and a "rate of change of range" of a moving vessel, from the D. P. F.; and that by means of these rates, the position of the vessel may be predicted, at the expiration of any given interval of time, provided of course that the vessel maintains the same rate of speed and direction. This is manifestly unsound in theory, as the azimuth changes as an equicrescent increment of time, only when the vessel is sailing on a circle, of which the D. P. F. is the center. The same is true of the range only when the vessel is moving directly towards or from the observer. It has been found by practice, however, that for small time predictions, say two minutes, this system will work with sufficient approximation, when the vessel is crossing the line of observation at an angle greater than 45°; at a less angle the system is worthless.

At this Post various methods have been tried, and it has been found that the most efficient work could be obtained by the use of a platting board, which is the theoretical and only accurate method of prediction.

The platting boards were arranged to plat by polar coordinates, in order to correspond with the D. P. F. system, and the method has been found to be accurate, rapid and practical.

With the platting board two additional apparatus are used. First, the Auxiliary Scale, by means of which the predicted point may be determined instantly at a glance, either for one, two or three minute predictions. Second, the Set-back Chart, by means of which the "set-back point" is determined. The command FIRE must be given when the vessel reaches a point, a sufficient distance before it reaches the predicted point, to allow for the time of flight of the shot and speed of the vessel, so that shot and vessel will arrive at the predicted point at the same time. This point we call the "set-back point." Both of these devices are simple and readily understood by the enlisted men.

The assumption upon which prediction is based, is that the vessel will during the time of prediction maintain the same speed and direction. This in practice has been found to be generally true, for large vessels having considerable momentum, provided that the vessel has not begun to turn at the beginning of the prediction. As the command *fire* is not given until the vessel has reached the set-back point, and as the time elapsing between the set-back and the predicted point is so very slight, change of speed will not affect the result materially, so long as the vessel maintains her direction; and a large vessel cannot turn in two minutes sufficiently to materially affect the range at which she will pass the predicted azimuth. In order to insure that the vessel has not begun to turn during the tracking, the platter should continue platting, until he has obtained four points, in a sensible straight line. The prediction to be made from the fourth point thus platted.

The command FIRE is given when the vessel crosses the predicted azimuth, whether the range is correct or not. Unless, of course, the error in range is excessive, when a new prediction may be made. In this connection it should be remembered, that it will require three minutes to make a new prediction, during which time the guns can be reloaded; therefore, it would be better to fire anyhow, taking the chances of hitting, and reload for the next prediction, as it is hardly probable that the error of range will be greater than the maximum error of the guns.

The principles above enunciated cannot be depended upon for very small vessels, therefore I am of the opinion that it will be useless to attempt predicted firing at torpedo boats. For such purposes R. F. guns are essential.

A careful consideration of the subject of firing by Case III, which is the most accurate method of firing, will show the aiming of the guns is actually done by the D. P. F. The direction range and allowances, for the guns are determined by means of the D. P. F. and auxiliary instruments in the B. C. Station, and the guns are merely mechanically laid to correspond therewith. Thus the entire problem of fire-direction is in the hands of the officer at the D. P. F., who will thus aim and fire all of the guns of the battery. This, therefore, is the proper work of the battery commander. In my own battery, after the prediction has been made, the observation sergeant turns over the instrument to the B. C. who gives the command fire, observes the effect of the shot, and if possible determines the error of fire.

The Drill Regulations while somewhat hazy upon the subject, imply that all atmospheric corrections, and computations are to be made in the B. C. Station, and the corrected range and azimuth for the directing gun is to be sent to all of the guns, after which the difference corrections are to be made for each gun, by the G. C.; and this method, although not theoretically accurate, is undoubtedly the most practical, and the error is so small as to be immaterial. Of course, theoretically, the difference chart corrections should be made before the atmospheric corrections are applied, the error will rarely however exceed one minute of azimuth, and can be ignored; while the advantage of making all the computations in the B. C. Station and sending the corrected range and azimuth to the guns is very great.

The difference chart used at the guns is a device for applying the data for the directing gun, to any other gun in the battery.

The difference of azimuth from any two guns to a given target, is equal to the angle at the target, formed by the intersection of the two azimuths. If therefore we know the angle at the target, we know the correction to be applied to the given azimuth. The difference chart is merely a polar coordinate platting board, on which are drawn iso-angular curves; each curve being marked with the angle which would be formed by two azimuths from the guns, intersecting on the curve. One of the two guns considered being the directing gun, and the other being the particular gun for which the chart is constructed. These iso-angular curves are generally drawn for every two minutes change of angle. It is therefore merely necessary to ascertain on or between which of these curves the target is situated, and we instantly read off the angular correction; which is plus or minus, according as the given gun is to the left or right of the directing gun. Each chart is of course distinctly marked with its proper sign. The position of the target can be instantly platted by means of the azimuth and range from the directing gun. The chart is furnished with a range allidade, and azimuth circle. The range corrections are also indicated on the chart, as functions of the azimuth. The iso-angular curves are circles, and therefore the chart is very easily constructed.

One of the advantages of the chart is that an error of 5° in laying off the azimuth, at ranges beyond 3,000 yards, will not produce an error of more than one minute in the difference angle. Of course I refer to not more than five guns, placed at the usual interval in batteries. In consequence of this fact, very rapid work can be done, as it is not necessary to be exceedingly accurate in platting the position of the vessel.

It should be remembered, that the difference in range, for any particular gun, cannot exceed its distance from the directing gun. For directions anywhere near normal to the front of the battery, it will not exceed ten or twelve yards. It is hardly possible that the difference in range will ever exceed the error of the gun. It therefore follows, that in firing salvos at moving vessels, range corrections by the difference chart may be neglected; and the G. C. should be instructed merely to correct for azimuth.

A little thought will show that under the system suggested, the only computation, made in the B. C. Station, is addition and subtraction of azimuth and range; at the guns also, only addition and subtraction of azimuth and range are made when using the difference chart. The elevation, for the corrected range is read off from the G. C. Table, and applied directly to laying, no addition or subtraction being necessary. In order to avoid the error due to subtracting or adding degrees and minutes, I have recommended that all azimuth circles be divided into degrees and hundredths, instead of degrees and minutes. It will be merely necessary to change the verniers on the guns; and the minute dial plates on the D. P. F., which will cost very little. At first it would appear necessary to change the deviating scale in the telescopic sights, this however is not the case. A point on these scales is equal to three minutes 3/60 of a degree, which is equal to 5/100 of a degree. Therefore the scale need not be changed.

There is no necessity for changing the graduation of elevation devices, which can with considerable advantage be retained in degrees and minutes.

The range finder detail, under this system, should consist of an observation sergeant and 6 privates, whose duties should be as follows.

No. 1. Assistant to observation sergeant reads and calls off range and azimuth.

No. 2. In charge of platting board.

No. 3. In charge of correction table.

No. 4. Computor.

No. 5. In charge of battery system of communication.

No. 6. In charge of fire commander's system of communication.

This of course differs materially from the detail, laid down in the Drill Regulations, but is necessary for an efficient system.

The method of tracking, and predicting the position of a moving vessel, is as follows.

The observation sergeant follows the vessel with the telescope, and at the third stroke of the time interval bell, stops long enough to allow No. 1 to call off the azimuth and range. No. 2 instantly plats the position ; and as soon as four points have been platted in a straight line, No. 2 calls out STOP.

No. 2 then applies the auxiliary scale, and plats the "predicted point" at two or three minute interval, as directed. He then calls off its azimuth and range. The observation sergeants sets the instrument and relocates, and No. 1 calls off the relocated azimuth and range, which is written down by Nos. 3 and 4. No. 3 determines the wind components, and calls off the corrections from the correction table. No. 4 makes the computations as indicated, and calls off the corrected range and azimuth, which No. 5 immediately sends to the guns.

No. 3 in calling off from the correction table should call it off as shown by the following example.

RANGE.—Minus 92 yards, plus 18 yards, plus 42 yards. AZIMUTH.—Minus 7 minutes, plus 5 minutes.

No. 4 merely adds or subtracts the figures from the range or azimuth as given.

In the mean time No. 2 has determined the "set-back point" and now calls off its azimuth and range. The observation sergeant sets the instrument accordingly, and reports to the B. C. "Instrument laid, sir."

The B. C. now takes the instrument, and having received the report from the battery that the guns are ready, commands fire as the vessel crosses the vertical hair, and observes the effect of the shot, and notes any correction he desires made, in allowance.

It requires one minute to track the vessel, and should not require more than thirty seconds to make the computations. This minute and a half is more than enough to load the gun, and therefore the G. C. has one minute and thirty seconds to lay his piece.

In tracking vessel drill, the following system was adopted at this post during the past season. The practice is divided into two classes, which I will call Preliminary Tracking Drill, and Service Tracking Drill.

Preliminary Tracking Drill.—In this practice there is supposed to be no drift or wind and conditions normal. Therefore the relocated range and azimuth are sent directly to the guns without correction. The command Fire is given as the vessel reaches the "predicted point" therefore no set-back is used. Each G. C. corrects for his own gun, by the difference chart for direction only. The gunner is on the sighting platform, and as soon as the vessel enters the field of his sight, he begins to follow with the cross-hair. When the command Fire is given, he stops and reads off the position of the vessel, in points right or left, on his sight. The B. C. gives the command Fire as the vessel crosses the predicted azimuth, and also determines the exact range of the vessel at that instant. The error in range of the vessel, taken in connection with the error in laying of the gun, as shown by the sight deviation, determines whether the shot would be a hit or miss. In considering the possibility of making a hit, I think it is a fair convention, to assume the 50% rectangle to be 60 yards long and 10 yards wide.

Service Tracking Drill.—This practice is carried on in precisely the same manner, except that all the corrections are made, and the corrected range and azimuth for the directing gun are sent to the battery. In this case the command Fire is given as the vessel reaches the set-back point; and the position of the vessel is taken not at the command Fire but at an interval thereafter equal to the time of flight for the range. This is best done by dropping a flag at the proper interval after the command Fire.

Special Note.—It will be found that there is, in all of the D. P. F. instruments now constructed, a lag back, in the relocating arm; which must be allowed for. It varies from 5′ to 13′ according to range, and must be determined for each instrument. The method used in making this allowance at this Post is as follows. By following the rule that in relocating the instrument must always be brought up from the left, the error will always be plus. A table of corrections for each 100 yards range, is made out and is in the hands of the computor, who merely adds the proper number of minutes to the corrected azimuth.

COMMUNICATIONS.

The proper system of communications between the F. C. and the B. C. stations and the guns, has not yet been determined upon; and as I am a member of the Board upon the subject, I do not feel that I should speak of any of the systems under consideration.

The telephone has proven entirely unsatisfactory. The bridging of three or more instruments on the same line, has been found to be impractical. The sending of simultaneous messages to several guns, is rendered impossible by the ensuing confusion. The varying capacity of men to use the phone, the uncertainty that two men will hear the message alike, the varying results produced by different voices, together with the number of hands through which a telephone must pass, have demonstrated that it is impossible to transmit ballistic data accurately by means of the telephone, especially if it is to be done rapidly.

In the case of ordinary conversation, where the hearer may get the substance of the message, although he may lose certain sounds or words; and where the sense of the message will enable him to catch words which otherwise would be indistinct, is an entirely different condition from that which applies to artillery work. Such a message as Range 7463 yards and Azimuth 213° 14′ must be distinctly heard and understood in every detail, in order that the data may be accurately transmitted; this cannot be assured by any telephone system.

It has also been found that the telephones as now constructed will not stand the blast of the guns.

The following may be considered essential in any system of communication, that may be adopted.

The height of tide, and the direction and velocity of the wind must be automatically recorded in each B. C. Station.

An accurate and rapid means of transmitting ballistic data, must be maintained, between the F. C. Station and each B. C. Station. Also from the B. C. Station simultaneously to each gun.

In addition to this a system of conversational communication is necessary between the F. C. Station and each B. C. Station, and from each B. C. Station to the battery. Where ever possible speaking tubes should be used for this purpose.

The devices used must be simple, direct acting, easily manipulated by enlisted men, and should not require continual adjustment; and as a paramount consideration, they must absolutely and with unvarying constancy record accurately the message sent.

General Discussion of Fire Direction.

On page 111, Drill Regulations for Coast Artillery, we find the duties of fire direction described as follows.

(a). Making certain that the orders relative to projectiles and charges are thoroughly understood and complied with.

(b). Identifying particular targets assigned, and transmitting this information to guns.

(c). Communicating order and rate of fire.

(d). Observation and correction of fire.

(e). Change of target in compliance with superior order or on personal responsibility in case of unforseen emergency.

(f). Maintenance of fire, and cessation when ordered.

Sub-head (a). This problem involves both the service of ammunition, and the method of controlling the same.

The system of ammunition service provided in our batteries, is very unsatisfactory; chiefly I think because the Engineer Department does not understand the problem. The rate of firing is not only a function of the speed of loading, but also of the time required to track and predict.

We may place the rate of firing of a 10-inch Battery at not more than one salvo every three minutes; all things considered. This rate can be maintained for six or seven salvos, by well trained details. Now the Engineers consider that if the ammunition can be delivered at a faster rate than this, the service is ample. The new continuous hoist will undoubtedly deliver the ammunition on the loading platform, faster than the guns can be fired, therefore the service is ample. This argument would appear at first sight to be unanswerable; it is however fallacious.

The service of ammunition must not only be sufficient to maintain a certain rate of fire, but also must be such that the kind of projectile to be used can be instantly changed without loss of time. In other words a sudden change of ammunition, must not change the rate of fire. It is manifest that this requirement is a function of something besides the mere rate of delivery of ammunition upon the loading platform.

Considering the continuous hoist to be the most desirable system of lifting ammunition from the magazine to the loading platform, the following conditions are essential in a properly devised system of ammunition service.

First.—There must always be on the loading platform, under proper cover, as many loaded ammunition trucks, as there are different kinds of ammunition to be served; each truck being loaded with a different class of projectile and its cartridge.

Second.—The empty truck as it returns from the gun, must be instantly loaded with the proper class of ammunition, necessary to maintain the first condition.

If the first condition is maintained: Whenever the G. C. calls for a certain projectile, the ammunition detail bring up the truck containing the particular kind of ammunition called for, and as all kinds of ammunition are on the platform loaded on trucks, no time is lost in loading.

To maintain the second condition, it is necessary that there should be on the platform at all times during action, one or more of each class of projectiles, ready to be loaded on the empty trucks. Finally this delivery table must be kept supplied continually with the particular kind of ammunition that is being used. Now suppose that the continuous hoist was coming up with say four D. P. Shells at the instant that the change was made to common shell, then those four D. P. Shell must be delivered before a common shell could be sent up. Therefore the delivery table should contain at least twice as many of each kind of ammunition, as can be carried at one time on the hoist. But if on the arrival of the supposed four D P. Shell it is found that the delivery table has its full complement of D. P. Shell in consequence of the sudden change in ammunition, what are you going to do with the four shell. You cannot send them back because they are being followed by common shell which you need. Therefore although the hoist may be capable of serving ammunition faster than the gun can shoot, it may not be able to supply a particular kind of ammunition as fast as is needed.

In considering this question, it is manifest that the problem could be instantly solved by constructing as many hoists as there were kinds of ammunition to be served. This I think is hardly necessary; two hoists and a properly constructed delivery table will solve the problem. But one hoist to be used at a time, hoists to be changed whenever ammunition is changed.

Take the example above cited; we have been firing D. P. Shell, and common shell is suddenly called for; No. 1 Hoist is in use and four D. P. Shell are on the hoist, and there is place for but one on the delivery table. No. 2 Hoist immediately begins to send up common shell. One of the D. P. Shell from No. 1 Hoist is delivered, and the remaining three, are taken back and unloaded, and the No. 1 Hoist is ready for the next change.

Of course this is merely a hypothetical case, as I have never used the new hoists, and do not know whether it is possible to lift four rounds of ammunition upon the lift at the same time. My experience has all been with the old system of platform lift. The new system is undoubtedly preferable to the old.

Let us now consider the control of the ammunition service by the B. C. All communication devices which I have seen, have been arranged so as to send to the guns, by one motion, the signals A. P. Shot, A. P. Shell, &c. The G. C. gives his commands accordingly, which information is immediately conveyed to the N. C. O. in charge of the delivery table, and by him called down to the magazine. I presume this would ordinarily be ample, in fact I have never heard it questioned. It must be admitted however that this does not comply with sub-head (a). The B. C. has no means of knowing that his orders are understood and complied with.

The following idea has suggested itself to me, and I give it for what it is worth. Construct at or near the B. C. Station a semaphore, from which can be shown colored disks. A red disk indicating A. P. Shot, a red and white disk A. P. Shell; a blue disk D. P. Shot, a blue and white disk D. P. Shell, and a white disk common shell.

These disks should be of a size to be clearly seen at the guns, but not of sufficient size to be seen far down the bay.

On the rear wall of the emplacement of each gun, to be placed two answering semaphores, one under control of the G. C. and one under control of the ammunition sergeant. An electric alarm bell to attract attention should be added. Whenever a signal for ammunition is made on the B. C. semaphore, it is immediately answered by the G. C. and A. S. as soon as received. In this way the B. C. is instantly informed that his orders are understood and complied with. The answering semaphores should be placed so as only to be visible to the B. C.

Sub-head (b).—I think this should read: Identifying particular targets assigned; and *indicating* the target to the guns when necessary.

By "identification" we understand two processes. First the selection of the assigned vessel, from several others in the fleet. Second, the determination of the class of vessel, whether battleship or cruiser, so as to properly select the ammunition.

The target must be *indicated* to the gunners. The reason for this is two-fold; the gunner must follow the vessel continually, so that when the corrected azimuth is sent to the guns, it will not be necessary to move the guns through a large arc; and furthermore when the fire control is turned over to the G. C., as it must be at short ranges, the gunner must be absolutely sure of his target.

The question of identification will be considered under the head of Fire-Control.

The problem of identification is simple. In fact it is practically done at the first prediction. The gun being set upon the predicted point, the gunner being on the sighting platform, he notes what vessels are in his field of view, as the gun goes off, and continues to watch for the splash of the shot. He should be able to instantly determine the target; if not at that shot, certainly by the next. It can however be accurately done before firing the first shot by means of the auxiliary range finder. The B. C. causes a prediction to be made, at one minute interval, sending to the battery the relocated azimuth and range. The A. R. F. is set for the point with proper differences, and at the signal from the D. R. F. he notes the vessel under his cross-hairs.

Sub-head (c).—The meaning of this is not exactly clear. It cannot refer to predicted fire, as the order and rate of such fire is entirely in the hands of the battery commander. It cannot refer to short range fire, as there would be no order of rate; at that epoch, get in as many shots as you can would be the rule. It possibly refers to the case where the B. C. leaves the Station in charge of the R. O. with directions as to order and rate.

Sub-head (d).—Observation and correction of fire should in my opinion be done by the B. C. himself, using the D. P. F. for that purpose. He is fully authorized under the Drill Regulations to leave this to the R. O. This undoubtedly refers however to the "instrument for the observation of fire" and its use. The instrument is however absolutely worthless, and no one would think of using it, for any purpose.

Sub-heads (e) and (f).—Require no special remark.

The Limit of Fire Direction and when it must Cease.

The long range, high velocity and great accuracy of our modern high power guns has materially changed the conditions of artillery fire. Atmospheric conditions which in olden times could be neglected, must be now carefully considered. Thus in temperate climates we may readily have a change of 10% in the weight of air from summer to winter. For a 10-inch B. L. rifle a change of 10% in weight of air is equivalent to a change of range of 190 yards at 7000 yards. A twenty mile wind, which is not a high wind, will at 7000 yards vary the range 30 yards, and it would not be exceptional to have, during the same day, variations, which would change the range from 50 to 100 yards. In order therefore to obtain the maximum efficiency from the gun at the long ranges, we are forced to carefully study the Barometer, Thermometer and Anemometer. Another condition which materially affects the problem of sighting, is refraction. Every one has observed a vessel which should be hull down, apparently thrown up in the air, so that, not only was the entire hull visible, but appeared to be above water. It is not uncommon to see at 5000 yards houses apparently lifted eight or ten feet in the air. At short range this does not materially affect the fire, but at long range it renders sighting by Case I practically useless.

There are also certain mechanical considerations, which play an important part in determining the limitations of practical fire direction.

Firing by Case I.

It is impracticable with an open sight to do accurate work beyond 1500 yards, by Case I, and even at that range it requires a well trained eye. The use of the telescopic sight increases the power of vision, so that aiming can be done up to the practical limit of direct fire; but beyond 3000 or 3500 yards refraction is so great, and its magnitude so uncertain, that we can practically fix 3500 yards as the limit for the use of Case I in artillery work. It may be asked why does not this affect the D. P. F.? It does, but we have a ready means of correcting for refraction, by simply turning the instrument upon a reference point, which is impossible with the sight, as too much time would be lost in traversing the gun. In this connection we may consider an important mechanical difficulty, which always militates against the use of telescopic sights. The instrument is so delicate that it cannot be left on the gun during firing, and it is impossible to be sure that it is seated exactly the same way every time; this is also true for open sights, it being generally necessary to take off the rear sight during firing, but the difference between front and rear sights is so great that a slight error in seating the rear sight makes no practical difference; whereas the telescopic sight is so short that a slight error makes a great difference. Thus take a ten inch gun, and assume that it is fitted with a breech and trunnion sight; they would be about ten feet apart. An error of .005 of an inch which is not noticeable by the naked eye, would at 10,000 yards make a difference of but about 6 inches on the target. Whereas exactly the same error in seating one of our telescopic sights would make a difference of ten yards at the same range.

Then again if you set a telescopic sight upon an object, you will find, that by moving your eye to the right or left, you can make the object appear fully two points to the right or left of the cross hair. This is the chief source of error generally spoken of as the personal equation of the man. It is also difficult to impress upon the average gunner that the sight must be absolutely level; they will conclude that it is "near enough" in spite of all the training that you can give them.

Case I can of course only be used in firing at stationary targets, and must be considered as the most inaccurate method of pointing a gun. I am well aware that it is generally considered to be the most accurate; and much of the poor artillery target practice is due to a persistent adherence to this idea.

Fire direction plays a very small part when this method of firing is used, and is confined entirely to indication of target, determination of ammunition to be used, and establishing the order and rate of fire.

Firing by Case II.

This method can be used both at stationary and movable targets, and as it eliminates entirely the errors due to vertical refraction, and also all errors due to the attempt to give elevation by means of a sight, it is vastly more accurate than firing by Case I. Of course the mechanical errors, and the errors due to personal equation, are the same as in Case I, and there is always the possibiliity of the gunner, in times of excitement, taking his allowance in the wrong direction. There is more scope for Fire Direction, and in certain conditions, especially at stationary targets, has a decided advantage; and men should be carefully instructed in its use.

Its use when firing at moving targets is of doubtful value. The gunner is required to perform so many mental operations, that it should never be resorted to except at ranges where the corrections to be made are simple, and essentially direct; that is, not requiring the consideration of both plus and minus conditions.

There is a point at which fire direction must be turned over to gun commander, after which Case II is the only method which can be used. It can readily be determined, for any particular gun, within what ranges this can be done, with reasonable assurance of efficient work.

Let us consider the 10-inch B. L. rifle. We may assume that a variation from the normal weight of air of 10%, and an accelerating or deviating wind of 30 miles per hour is the maximum with which we are likely to have to contend. At any range where such conditions will not produce a vertical deviation of more than one-half the free-board, and a lateral deviation of more than one half the beam of the vessel, we may neglect these corrections.

The standard free-board is 15 feet, and the beam is 72 feet.

Now at a range of 3,000 yards a change of 10% of weight of air will vary the range 39 yards and a 30 mile accelerating wind will vary the range 10 yards. Total variation when acting together 49 yards, and as the slope of fall is one on twenty-three, this will give a vertical deviation of about 6 feet. At the same range, the drift is 2.6 yards, and a 30 mile deviating wind 5.4 yards, total when acting together 8 yards. From which it will be seen that at this range while the lateral deviation will be much less than ⅛ the beam of the vessel, the vertical deviation will approach closely to ½ the free board. Considering the errors in sighting, this is about the maximum range at which these corrections may be neglected. Consequently within 3,000 yards range, all corrections for drift, air or wind may be neglected when firing at a vessel of the ordinary size of a man-of-war. The only correction which the gunner must make is for speed of vessel, which is simple and always made in the same direction. Therefore within 3,000 yards the fire control can be safely turned over to G. C. with the 10-inch B. L. rifle. As the time of flight for this range is less than 3 seconds, during which time a vessel going full speed could not travel ½ its length, a shot aimed at the bow, would be sure to hit the vessel. This has been computed for the 10-inch B. L. rifle, but roughly speaking we may consider 3,000 yards as the maximum range for the use of Case II for the 8-inch, 10 inch and 12-inch B. L. rifles.

The fire direction during this epoch, will consist of control of commencing and ceasing fire, character of ammunition to be used, and indication of range, observation of fire, and correction of aim when required, and when possible.

Firing by Case III.

From what has gone before, it is manifest that complete Fire Direction using Case III is the proper method to employ, when firing at moving vessels at ranges beyond 3,000 yards. The method of doing this has already been indicated in this paper. Case III is also the most accurate method which can be employed, in firing at stationary targets.

The chief errors in this method of firing are due to the following mechanical conditions.

1st. Elevating system not in adjustment, easily corrected.

2nd. Azimuth vernier, not in adjustment, easily corrected.

3rd. Traversing center of carriage not concentric with azimuth circle. This cannot be altered, but must be carefully determined, and allowed for.

4th. Axis of gun not parallel with axis of carriage, when the gun goes in battery. This error increases with the wear and tear on the carriage, and when it becomes so great that accurate fire is no longer possible, the carriage should be condemned. With a properly constructed carriage, this error should not exceed one minute plus or minus. This error will probably increase more rapidly with carriages which have the greater number of moving parts; and therefore it is fair to assume that it will increase more rapidly in the case of disappearing carriages than in the case of barbette carriages.

Adjustments.

The adjustment of the azimuth vernier should be done at a reference point as nearly in the center of the principal field of fire as possible. This point we will call the initial reference point. The correctness of the adjustment should be tested at the extreme limits of motion, to the right and left; assuming the triangulation to be correct, if the readings of the reference points do not coincide with the triangulation the error is probably due to eccentricity. Now work from left to right and back several times and note whether the initial reference remains constant; if so the eccentricity is constant, and may be easily allowed for. If the reading of the initial reference does not remain constant, the eccentricity is variable. It generally happens that the eccentricity is very slight, and an approximate correction can be established; if not, the fact should be reported to the Ordnance Department and the carriage should be overhauled.

A good way to mark such corrections, is as follows. Paint on the epaulment several arcs, numbering them —1′ or +2′, etc., when the muzzle of the gun lies within these arcs, one or two minutes must be subtracted or added to the azimuth.

The adjustment of the elevating arc is generally very simple, but with the disappearing carriages, it will be found that when you adjust for zero that it will not be in adjustment at 12° elevation and vice versa. Care must be taken to adjust at that elevation, which will give the nearest approximation within the most important field of fire.

FIRE CONTROL.

Fire Control is defined in the Drill Regulations as "the conduct of any system of artillery defense for tactical objects." By which we understand, that Fire Control is the method of conducting the tactical operations of any system of artillery defense.

The exercise of fire control is divided into ten sub-heads; which we will consider more or less in detail.

Sub-head (a).

"The decision, *immediately on assuming command*, of the general lines on which action is to be taken under the different conditions of attack, and as far as possible of the details."

This seems to convey the idea that each commanding officer should, on assuming command, prepare a detailed Scheme of Defense, involving everything which may be anticipated, taking into consideration the various forms of attack that may be anticipated. Such a scheme should in my opinion always be in existence, be thoroughly discussed, as a part of the winter lyceum course be added to and improved, be published in orders, and carefully entered in the Fort Record Book in full detail. New commanding officers would probably alter the scheme from time to time, according to their own ideas. All such alterations should be entered in the Record Book, so that who ever may be in command at the breaking out of war, will be able to obtain the views and experiments of his predecessors.

Sub-head (b).

"Decision *beforehand* of the nature of projectiles to be used against different classes of ships at different ranges."

The word "beforehand" must be interpreted as referring to a specially prepared plan, made after careful consideration, and not simply to the time just before the action begins.

The idea of the Board, as can be gathered from the spirit of the entire system, was that there should be prepared, for each battery, an identification chart, which should contain instruction, as to the kind of ammunition to be used at various ranges, for each class of ship. In my opinion such a chart would be so complicated, and contain so much data, that it would be practically useless in time of action. I constructed one, for one of the batteries at Fort Hamilton, at the breaking out of the Spanish War, and after completing it I was satisfied that it was too complicated for practical use, and that such refinement of detail was not necessary.

I devised a plan for this Post, which however has not yet been carried out, in consequence of want of time, which in my opinion, will satisfy all of the requirements of the case.

The field of fire of each battery to be carefully considered, and each battery platting board, to be divided into zones, tinted as follows.

Zone in which A. P. shot and shell must be used..........RED.
Zone in which D. P. shot and shell must be used..........BLUE.
Zone in which common shell must be used ....WHITE.

This to be worked out for a battleship. If the battery is engaged with any other class of ship, the ammunition used will be powerful enough to do the work requirrd of it. Whether shot or shell is to be used to be left to the judgment of the B. C. It might be advantageous to carry out the Red Zone beyond the battleship limit, with lighter tints of red, indicating the range at which A. P. shot or shell can be used against armored or protected cruisers.

With this system, the B. C. can at a glance, determine what ammunition to use, as soon as the predicted point has been platted ; and in fact even before that point has been reached.

Sub-head (c).

"Immediately before and during action, identification of class of enemy's vessels."

As already intimated, I consider this an unnecessary refinement. Every B. C. can tell a battleship from a cruiser, a big cruiser from a small one, if he follows the rule always to be sure to use the ammunition suited to the most powerful vessel of its class, he will not be far wrong.

Sub-head (d) requires no remark.

Sub-heads (e, f, and g).

"Assigning to the different 'Battery Commands' the vessels they are to attack."

This important work must be divided into two parts, day work and night work. The systems used at this post with great success, during the past season may be described as follows.

Day Work.

The F. C. with his R. F. detail, his aides and orderlies is at the F. C. station. The detail consists of an O. S., No. 1, his assistant, No. 2 at platting board, and No. 3 at the telephone.

The F. C. selects a target, directs its position to be platted at one minute interval, and then sends the following commands through the telephone.

Battery A, prepare to locate target.

or

Batteries A, B, and C, prepare to locate target.

or

All batteries, prepare to locate target.

According as he desires, one, three or all of the batteries to attack the selected target.

As soon as the predicted point has been determined, its position is telephoned as follows.

Azimuth ——— Range ———

The D. P. F. is set on the predicted point, and as the vessel enters the field the cautionary command READY is sent to the batteries. As it passes the cross hairs the command Now is sent to the batteries.

The command is then given.

Such battery (or batteries) Commence Firing (or at such range commence firing).

Work at the B. C. Stations.

Each B. C. station is fitted with a B. C. difference chart, constructed upon the same principle as the G. C. difference chart, which gives the difference in azimuth and range between his own station, and that of the Fire Commander.

As soon as the B. C. receives the azimuth and range of the predicted point from the F. C. station, he immediately corrects for his own station, by the difference chart, and the O. S. sets the D. P. F. upon the indicated point, and the B. C. takes the instrument, and at the command Now, identifies the target. He indicates it to the O. S. and sees that it is thoroughly recognized. He then directs predictions to begin, and commences firing as directed by the Fire Commander.

Night Work.

Each battery has a search light, and the fire commander has a light under his own control. Search lights are known by the names of their batteries.

At the command "Prepare to locate targets" all beams are thrown upwards. The F. C. search light is then brought to bear upon a selected target, and the command is given.

Battery A, search light cover.

or

Batteries A and B, cover.

or

All search lights cover.

The indicated search lights all cover the target, and as soon as the F. C. ascertains that the proper target is covered he commands FOLLOW when all the indicated search lights follow the vessel, although the F. C. light is immediately withdrawn. The command is then COMMENCE FIRING.

The RULE of night firing is that all batteries fire upon the target illuminated by his own search light, and continue the work until the command Cease Firing is given, or the target passes out of the field of fire of the battery.

It is manifest that by this system targets may be easily assigned to the batteries and fire may be concentrated or dispersed at will.

The system worked in a very satisfactory manner at this Post during the past season.

Sub-heads (h, i, and k) do not require any remark.

The experience at this Post during the past season has demonstrated, that Fire Control, when using the D. P. F. system is entirely practicable, and a problem of very easy solution. Whether it is possible with a horizontal base system of position finding, is very doubtful.

Search Lights.

Time will not admit of a thorough discussion of this very important subject, I will however give the results of the experience at this Post, taken in connection with the results noted at the Army and Navy maneuvers at Newport, R. I., during last Fall.

Search lights may be divided into three classes depending upon their use: search lights proper, illuminating lights, and blinding lights.

SEARCH LIGHTS.—These lights are intended for searching the harbor for incoming vessels; they should be kept continually in motion, and should be made to cover as great a field as possible. In order to obtain the best effect from these lights, it is important that the observer should be under the light. The beam of light throws a reflected ray upon the water, parallel to itself, which gives sufficient illumination to detect the presence of any vessel and covers a great area. An observer above the beam cannot use this ray, and must therefore depend only upon the illuminating effect of the beam. It is therefore necessary that the observer should be below the beam, in order to utilize the light to the best advantage.

These lights should be under the command of an officer, who should be in direct communication with the Fire Commander.

ILLUMINATING LIGHTS.—These lights are intended to illuminate the vessels of the enemy. Each battery should have one light which must be under the control of the B. C. It should be placed in front of the battery, and below the guns. For the most efficient work in this case, the observer must be above the light. It is impossible to work through a beam, and therefore all beams must if possible be kept below the line of vision from the D. P. F.

BLINDING LIGHTS.—These are intended to blind the eyes of the pilots, and should be placed in prolongation of the channel as near as may be. They should be extremely powerful lights, and should be under the command of a special officer.

In addition to the above, the F. C. should have a light which he may use in such manner as he may deem proper.

The F. C. light and illuminating lights should be under electric control from the stations; the remaining lights may be fitted simply with hand control.

D. P. F. versus H. P. F.

There is a great difference of opinion among artillery officers as to the relative value of the two systems of position finding.

The friends of the D. P. F. system admit freely that for determining the position of a fixed target, the horizontal system is necessarily more accurate than the D. P. F. system, it is however contended that the double possibility of error due to the necessity of using two observers, renders the H. P. F. system more inaccurate than the D. P. F. system in determining and predicting the position of a moving vessel. In fact so far as I am informed no method has as yet been invented whereby a B. C. can indicate to the secondary station exactly the target he desires to be followed nor can he be sure at any time, that the observer at Station "B" is following the same vessel that is being followed by the observer at Station "A."

I know of no means of applying the principles of fire control to the H. P. F. systems.

This being a subject of great importance, let us consider the matter in detail.

A fleet is entering the harbor, and the Fire Commander desires to rapidly assign to each battery its particular target. With the D. P. F. this is simple, as he can instantly determine the range and azimuth of each of the vessels of the fleet. With the H. P. F. system he can not determine the range of any vessel until he has indicated the particular vessel to the observer at his own secondary station. He cannot say follow the first or second ship, as he does not know whether the ship which appears to be the first to him, appears in the same relative position to the other observer. To describe the vessel through the telephone would consume too much time, and would be of doubtful accuracy. With the D. P. F. system we can readily assign six targets in ten minutes; how it is to be done with the H. P. F. system, except by the tedious process of description through the telephone I do not see.

After the position of the vessel is obtained and a predicted point has been determined, and sent to the B. C. station, how is the B. C. to lay on that point?

The B. C. having the range and azimuth, can of course lay his own instrument correctly upon the point; he can not, however, determine what vessel is on that point until he receives a record from the secondary station. How can he possibly indicate the position of that point to the observer at the secondary station? In my opinion the time lost in talking back and forth to insure accuracy would render Fire Control and Fire Direction a simple farce.

The advocates of the H. P. F. system maintain that however valuable the D. P. F. system may be on high sites, that it is impracticable on low sites, in consequence of the necessity of constructing high towers, which become conspicuous targets for the enemy. I doubt the force of this argument. A naval force can do the tower but little damage, if any, until they are within 2500 yards, at which range fire control has ceased.

It is also claimed that the D. P. F. cannot be used over stretches of sand in the south, in consequence of refraction and mirage. As to this I cannot express an opinion having had no experience.

The problem is a very important one and some solution should be obtained as soon as possible.

I have endeavored to give a mere outline of this most important work, and have been obliged to leave out many minor details, and have only touched upon those points which appear to me to demand special thought and consideration.

G. N. WHISTLER,
Captain, 5th Artillery.

Abbreviations used.

B. C.	Battery Commander.		
D. P. F.	Depression (Vertical Base) Position Finder.		
H. P. F.	Horizontal Base Position Finder.		
F. C.	Fire Commander.		
G. C.	Gun Commander.		
O. S.	Observation Sergeant.	A. S.	Ammunition Sergeant.
R. F.	Range Finder.	R. O.	Range Officer.

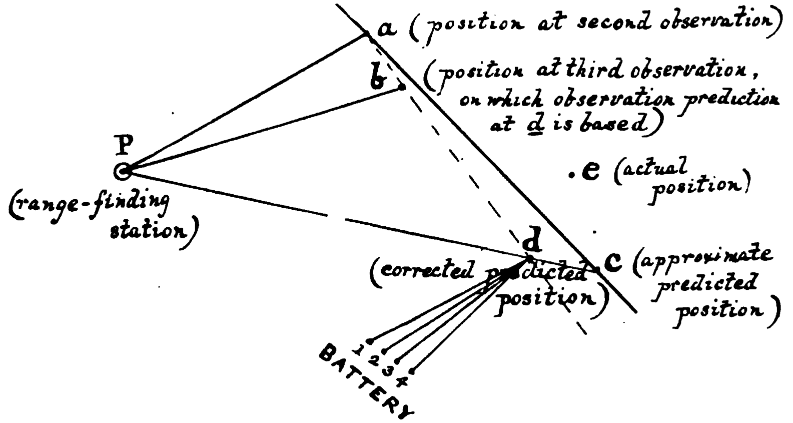
AUTOMATIC SIGHTING AS APPLIED TO SEA-COAST ARTILLERY FIRE.

An automatic sight is a mechanical sight so constructed and attached to the gun that the act of sighting on the water line of the target gives the gun the elevation corresponding to the range of the target. Its construction is based upon the same principle that is made use of in the construction of depression range finders, namely :—given, the height of the axis of the sight above the sea-level and the angle of depression to the target, all other parts of the right triangle whose hypothenuse is the line of sight, whose base is the intersection with the sea-level of the plane of sight, and whose leg is the vertical distance between the axis of the sight and the sea-level, may be found.

Before inquiring whether such a sight can be constructed so that it will give satisfactory results for different heights of tide, so that, when for any cause, the gun does not shoot true to its range table, it can still be adjusted to insure accuracy, let it be considered what advantages or disadvantages may be expected from its use. Admitting, then, for the present, that it is possible to construct such a sight and to construct it in such a way that all difficulties may be overcome, why should it be used instead of the present system of sighting and laying guns on information received from a range-finder?

Firing at a moving target is the most inportant case with which sea-coast artillery has to do. From a study of the Drill Regulations for Sea-Coast Artillery and a more or less thorough carrying out of its directions, the following is believed to be the method that would be pursued in firing at a moving target. A consideration of the details of this method impresses the mind with the numerous opportunities for error in it, the greatest of which is the employment of a range for elevation which the target is supposed to have two or three minutes after the last measurement of the range.

The Battery Commander, under instructions from the Fire Commander, first sends to his battery, which, let us suppose, is a 12-inch Breech Loading Rifle battery of four pieces, directions as to the target against which fire is to be directed, the part of the target to be aimed at, and the kind of projectile to be used. He then causes the observer at the range finder to direct his telescope on the target and at equal intervals of time, say two minutes, call out the range and azimuth to the target, as recorded by the instrument, which is immediately relocated for the directing gun of the battery by No. 1 of the Battery Commander's detail, who calls out the result of his relocation as soon as possible. At least two such observations and relocations are necessary to enable the Battery Commander to determine the rate of change in range and azimuth of the target from the directing gun of the battery.


a (position at second observation)
b (position at third observation, on which observation prediction at d is based)
P
(range-finding station)
e (actual position)
d
(corrected predicted position)
c (approximate predicted position)
1
2
3
4
BATTERY

Suppose that at the *second* observation, the target is at *a*, at an actual range of 5000 yards, and azimuth of 300 degrees from gun No. 1, the directing gun of the battery. By means of this observation and the first, its course is determined as well as its speed, and if it holds this course and speed, it will be at *c* in three minutes. The range and azimuth of this roughly predicted position are sent to the gun, that the guns may be approximately laid and the gun differences applied. What it is next necessary to do is to send a corrected predicted position, this position to be based upon an observation taken as short a time before the firing as possible. Therefore, as short a time before the firing (which must be done the time of flight before the expiration of the three minutes) as an observation can be taken and the fourth or corrected position of the target at *d* be predicted, the range to *d* from *P* relocated for the directing gun of the battery, corrected for atmospheric conditions as determined by No. 4, for height of tide, for travel during time of flight, the deflection corrections for drift, for wind and for travel made, the corrected range and resultant deflection correction sent to the guns and the guns laid —as soon before the firing as all this can be done, an observation is taken on the target, now at *b*, and its position at *d* predicted, the range and azimuth to which, properly corrected as indicated, is transmitted by No. 3 to the directing gun of the battery over the dial-telegraph. The observation at *b*, the prediction of the target at *d*, the making of the range and azimuth corrections, the transmission of this information to the guns, the laying of the guns, must all be done before the time of firing, which, as said, must be the time of flight before the expiration of the three minutes. Then, if the target retains its new course, if all these operations have been correctly done and the guns are fired the time of flight before the expiration of the three minutes, the projectiles should meet the target at *d*. The guns could be fired from the range finding station if connected electrically with it, or they could be fired by the Gun Commanders, if synchronous clocks were provided enabling them to tell when the instant marked by the three minute interval less the time of flight had come.. But, in all probability, the target will not hold its course and be at *d* when we want it to, but may have gone to some other position, as *e*. If the observation on which the corrected predicted position, *d*, is based, that is, if the observation *b*, could be made ten or fifteen seconds before firing and all corrections and intermediate work before firing done in this ten or fifteen seconds, the probability would be increased that the corrected predicted position and the actual position of the target at the end of the three minutes would coincide. In fact, conceive a rectangular set of co-ordinate axes in which the abscissas correspond to times elapsing between the observation *b* and the firing, and in which the ordinates correspond to the probabilities that the actual and corrected predicted positions of the target coincide at the three minute interval. Then, the ordinate of the curve connecting these probabilities and times will be greatest when $t = o$, and least when $t = \infty$. That is, the probability that these positions will coincide and therefore that the target will be hit is a decreasing function of the time elapsing between the taking of the observation on which the corrected predicted position of the target is based, and the time of firing. With the present method, it is believed that at least two minutes must elapse between the taking of this observation and firing, and as short a time as two minutes will be conceded only when trained gunners, observers and operators of large practice are working.

The method in which an observation is taken, and the range and azimuth, properly corrected, are sent to the guns and the guns fired as soon as possible, having been laid on this information, may be adopted in preference to the method first described.

Or, it may be found by practice advantageous to allow a constant interval of time between the last measure of the distance of the target and firing, corrections to be made accordingly and this interval to be preserved no matter what the range or direction or speed of the target. But it is believed that either of these methods is less accurate than the first; and in any case, too much time elapses between the last measure of the distance and the arrival of the projectile. This time must be reduced; its non-reduction introduces a fatal error, and it is believed the means of doing this is found in the automatic sight.

This conclusion more clearly appears from a closer consideration of the time in question, that is, the time between the last measure of the distance and the arrival of the projectile, which may be divided into three periods.

1. The lost time. This is the time elapsing between the last measure of the distance and the completion of the aiming. With the present system of laying guns on information received from the range-finder, an estimated mininum for this time is two minutes, and as said, as short a time as two minutes will be conceded only under the most favorable circumstances. In this two minutes, the target may have left its course and be anywhere except where it should be to be hit. With the automatic sight, this time is reduced to nothing, for the gun is laid as soon as the distance is found. Reverting to our curve of probabilities, we see that the probability is greatest that the target will be hit when $t = o$, and thus the automatic sight makes for greater accuracy of fire.

2. The dead time. This is the time elapsing between the completion of the aiming and the departure of the projectile. It is short and can be fixed in an uniform way. Indeed, it can in general be allowed for by laying the gun on the front part of the target.

3. The time of flight. The corrections in the range and direction of the target for the time of flight can be quickly made on the automatic sight by a gunner familiar with his tables, this correction in direction to be in addition to the correction for the dead time made by aiming at the front of the target.

Using our present method of firing at a moving target, observations should be taken at equal intervals of time throughout the action in order to track the target and furnish the necessary data for approximate prediction. To furnish corrected predicted positions, an observation must be taken in these intervals of time on which to base the corrected predicted positions. It then becomes very probable that due to excitement and nervousness, these two observations will become confused, one taken for the other and vice versa, and in consequence, that absurd results will follow. If their confusion with each other is discovered in time, another interval must pass before information can be sent to the guns on which to lay them. Then slowness of fire results. It may be said that an observation to determine a corrected predicted position is not necessary, that the interval between successive observations should be reduced to as small a time as possible and that the observation on which the predicted position is based can be sufficiently corrected for practical purposes. Our firing at a moving target is then predicted firing, an employment of Case III, and this impresses one at once as being inefficacious. Exclusive of the use of the automatic sight and the system of fire direction based on its use, it then appears that any of our present methods which may be adopted for firing at a moving target has within itself too many opportunities for error,—either the theory is bad, as when we use simple predicted firing, or the practice of the theory involves a quickness, skill and freedom from error hardly to be expected from the personnel of a battery of artillery. What method of fire direction shall then be adopted against a moving target? Use the automatic sight, is believed to be an answer. That is, given a working automatic sight capable of the necessary adjustments, greater accuracy of fire and greater rapidity of fire can be had against a moving target.

Under the present system of fire direction, the service of a coast battery is intended to be almost wholly directed by its Battery Commander, from whose station at the range-finder the information necessary to the intelligent and accurate laying of the guns proceeds. These range finders are in general located conspicuously and their detection by an enemy could not be avoided. They would offer a most desirable target for his guns both quick-firing and heavy, knowing that reducing the range finding tower or disabling the instruments in it means loss to a group or groups of guns of the possibility of being intelligently laid. In such event, the only recourse would be for each gun commander to lay his piece on estimated ranges, speeds, etc., which, being done hurridly and in the midst of confusion, would probably be incorrect. It then seems that automatic sights would find in their use in case of damage to the range finder sufficient reason for being adopted. They are convertible from ordinary tangent sights to automatic sights by the turning of a bolt or lever, as will be explained further on. In any case, if one of the automatic sights is damaged and made useless, it is only one of the sights of one gun disorganized and not a group of guns or an entire battery.

It is objected that an automatic sight will entirely separate the battery in action from the control of its Commander, and one writer holds that this is the most injurious argument that is advanced against the instrument. It is believed, however, that if some scheme of fire direction, such as is outlined in the succeeding paragraph and which is suitable to the changed conditions, be adopted, the Battery Commander will not only be able to get more accurate and rapid work out of his battery, but will also be able better to direct the fire of his battery, keep it longer in hand and more surely locate the cause of errors, not being concerned at the same time with furnishing data to the guns, to do both of which satisfactorily is believed to be of the greatest difficulty.

Let the fire of each gun be observed by its own layer, of each group by its own group commander, of each battery command by its own Battery Commander, in those cases, of course, where the Battery Commander is responsible for the service of more than one group. The layer should then correct his own fire as an ordinary rule, the group commander if he thinks necessary and the Battery Commander only in the event of erratic shooting which does not seem to be meeting with attention, he would probably do well not to interfere unless he deems it absolutely essential. The control of the battery is in no way taken out of the Battery Commander's hands. He gives directions as to the target to fire at, acting under instructions from the Fire Commander, tells what part to aim at, when to fire, what projectile to use, the order or rate of fire, when to change the target, and, as was said, corrects erratic shooting that seems to be due to want of attention. A system of fire direction similar to this would also be more economical, doing away with much costly material now necessary and not withdrawing from the service of the guns so many men for special details.

That a working automatic sight would result in greater efficiency in a coast battery is believed to be a warranted conclusion from the existing conditions of fire direction that have been set forth and the alterations in this method of fire direction that the adoption of the automatic sight would necessitate. The mechanical details of such a sight are next to be considered to the end that it may be determined whether there is yet an automatic sight of a construction simple enough, of a working correct enough, to make its use advisable.

The apparatus to which attention is first invited is represented by Fig. 1 of the drawing and was first described by Lieut.-Col. Sir G. S. Clark, K. C. M. G., and G. H. Banister, of Woolwich, England, in 1897. This sighting gear is so arranged that the sights are not only available for laying the gun in the ordinary manner, but are also adapted to be automatically adjusted to the range of any object on which the gun is directed. Either mode of using the sights can be adopted at will, the change from one mode to the other being effected very conveniently and expeditiously as hereafter described.

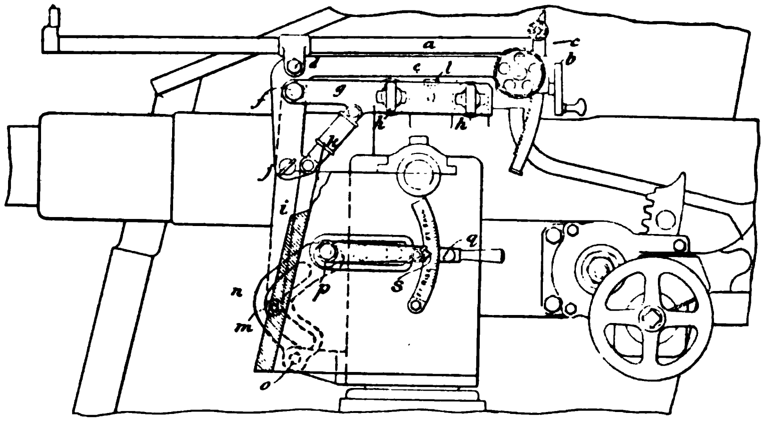


Fig. 1.

In the drawing here shown, the fore and rear sights are carried at the ends of a hinged or pivoted bar, *a*, and these sights may be adjusted in the ordinary manner to suit any estimated range by worm gear controlled by a hand-wheel, *b*, the desired range being indicated by graduations on a drum, *c*. In sighting apparatuses where the fore and rear sights are carried at the extremities of a pivoted bar, the bar has heretofore been hinged directly to the gun cradle or carriage, but according to the present arrangement, a movable arm is interposed between the bar, *a*, and the cradle ; that is to say, the bar, *a*, is pivoted at *d* to a bent arm, *e*, which in turn is pivoted at *f* to a carrier bar, *g*, fixed to the gun cradle by the screws, *h h*. Also pivoted at *f* is another arm or lever, *i*, which is controlled as will be described further on, and which can be locked to the arm, *e*, by a pin, *j*, so that the two arms, *e* and *i*, will turn about the common pivot *f*. If it be desired to use the sight in the ordinary manner, take out the pin, *j*, so that the two arms, *e* and *i*, are independent. The arm, *i*, has nothing to do when the sight is used in the orninary manner. The pin, *j*, having been taken out, the springs in *k*, which are always under compression, revolve the arm, *e*, about its pivot *f* till it bears on the adjustable screw stop, *l*. This stop is for the purpose of making the line of sight parallel to the axis of the bore when the drum reads o yards, if, for any cause it should not be. The sight bar, *a*, can now be given any inclination to the axis of the bore by means of the worm wheel, *c*, which is carried on the rear of the arm, *e*. To make this sighting gear an automatic sight, lock the arm, *i*, to the arm, *e*, by the pin, *j*. The only way in which the sight bar, *a*, can now move, is by moving the arm, *i*, which first moves the arm, *e*, on which *a* rests. The arm, *i*, terminates in an anti-friction roller, *m*, moving in the cam, *n*. Therefore, the arm, *i*, can not be moved in any way, and consequently the line of sight can not be changed in any way, except by revolving the gun about its trunnions. Doing this causes the roller, *m*, to assume various positions in the cam, *n*, and in consequence, it imposes different directions on the line of sight. The whole secret of the automatic working of this sight lies in the design and curve of the cam, *n*, which is of such a design and curvature as to produce the required relative movement of gun and sight.

For accurate shooting over the sea, it is absolutely necessary to provide for the adjustment of the apparatus according to the variations of the target level due to the ebb and flow of the tide. For effecting such adjustment, the cam, *n*, is hinged to the gun carriage at *o* and the upper end of the cam is controlled by an eccentric, *p*, which is operated by a lever, *q*. A scale is provided as shown on which the rise and the fall of the tide in feet are graduated, *s* being an index to denote on this scale the position to which the lever must be set to adapt the aim to the height of tide at time of firing. In this way, by adjusting the lever, *q*, the position of the cam, *n*, relatively to the sighting gear, gives the necessary corrections for variations of the tide.

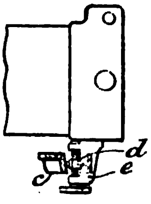


Fig. 2.

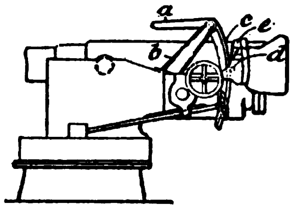


Fig. 3.

The automatic sight next shown was first described by Captain H. F. Gaynor, R. E., Chatham, England, in 1896. The sight, *a*, which may be a telescope, is pivoted on the bracket, *b*, as is also the curved bar, *c*. The sight, *a*, and bar, *c*, must be rigidly connected or formed out of one casting, and revolve in common about the pivot, which is part of the bracket, *b*, extending out from the top carriage. The weight of the sight, *a*, causes the bar, *c*, to bear against the stop, *d*, shown in plan in Fig. 2. Thus, the movement of the gun about its trunnions produces the required relative movement of the sight, the bar, *c*, being curved in such a way as to do this. For instance, the distance to the target is known to be 3000 yards. Then, the gunner elevates his gun until the horizontal wire of his telescope cuts the water line of the target and if the curve of *c* is properly designed, his gun should have the tabular elevation corresponding to 3000 yards.

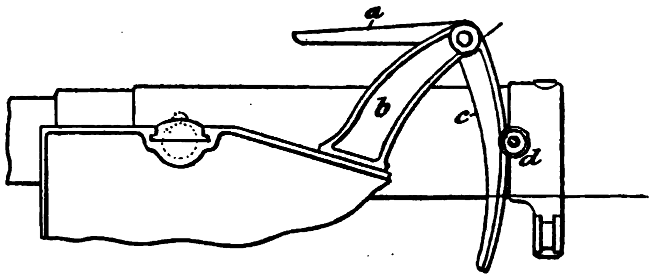


Fig. 4.

In order to make adjustment for different heights of tide, the curvature of the edge of the arm, *c*, is suitably varied in different planes of its width, and the stop, *d*, is made adjustable by the screw, shown in Fig. 2, so as to bear on any part of the width of *c*, according to the state of the tide, the stop being provided with an index moving along a scale, *e*, graduated to periods of the tide. Deflection corrections can be made by means of a movable vertical hair inside the telescope, which moves across a scale graduated in minutes. On the sight first described, deflection correction can be made by the wheel above *c* and *b*.

Fort Howard, Baltimore, Md., February 1, 1901.

FRED H. GALLUP,
2d Lieut., 4th Arty.

AN ISTHMIAN CANAL FROM A MILITARY POINT OF VIEW.*

GENERAL PETER C. HAINS (COL. ENGRS.), U. S. A.

56TH CONGRESS, 2d *Session.* SENATE. DOCUMENT No. 199.

FEBRUARY 27, 1901.—Ordered to be printed.

Assuming that an isthmian canal will be built by the United States, the question arises how can it be made to subserve the best interests of the Government from a military point of view. Should it be free to the vessels of all nations on the same terms, in war as well as in peace, or should it be controlled by military power, so that its use by our enemies in time of war could be prevented?

It is not proposed to discuss the cost of putting the canal under military control, nor the ways and means of so doing. It will be assumed that it can be put under military control, or that it can be made free, at the pleasure of the United States.

An isthmian canal can not be built within much less than ten years. What the relative naval strength of the various powers will be at the end of that period it is impossible to tell. Moreover, it is not easy to assign the proper place to some of the naval powers to-day. One nation may be strong in defensive but relatively weak in offensive power. The number, size, and power of battle ships and cruisers may not furnish the correct data for assignment of place. Naval training and geographical position are important considerations. The submarine boat is an unknown factor. But judging by the official list, the principal naval powers have not greatly altered their relative position in the last ten years. The United States and Japan have forged ahead; Spain and Italy have fallen behind.

The eight strongest naval powers stand about as follows: (1) Great Britain, (2) France, (3) Russia, (4) United States, (5) Germany, (6) Italy, (7) Japan, (8) Spain. Of these, Great Britain and France are decidedly stronger than the United States. Russia, the United States, and Germany are approximately equal, and all others decidedly inferior to the United States.

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* Mr. Morgan presented the following paper entitled "An Isthmian Canal from a Military Point of View," read by Peter C. Hains, U. S. A., before the American Academy of Political and Social Science.

War may take place between the United States and any of the other named powers, or combinations of two or more, or it might be with one of those allied to some weak power not in that list. It is impossible to foretell all the combinations that might arise, but it is probable that if an alliance of any two or more powers should make war against us we also would have allies; so that in dealing with the question we shall consider only the cases of war between the United States and a single power.

Let us suppose a war exists between the United States and some nation of inferior naval power. What effect would the existence of the canal have on the operations of either belligerent? The nature of the operations of both would depend largely on the geographical position of that enemy, the more or less maritime character of the people, and the value of her commerce and colonial possessions. Our policy would be to attack her war vessels wherever they could be found, shut them up in harbors by blockade if they could not be reached, bombard naval stations, possibly invade her territory if the conditions favored and the probable results justified it.

Japan, a young and vigorous naval power, occupies a favorable geographical position to operate against us in the Far East, and is fairly well provided with modern cruisers for attacking our commerce in the Pacific. An attack on the Philippines is within the limits of probability. If successful, Japan might even make a naval demonstration as far eastward as our Pacific coast, but it is difficult to understand how a condition of affairs could arise that would make it desirable for her to send a fleet through an American itshmian canal to the Atlantic side. Such an event could only happen in case our navy in the Pacific were destroyed and that on the Atlantic side perilously weak, a condition which it is safe to assume is not likely to arise in a war with Japan.

As for the European nations that are inferior to us in naval power, none are capable of conducting important naval operations against us on either the Atlantic or Pacific sides of the United States, and none are provided with naval bases of supply in such proximity as to cause us any alarm. Some of them might send out cruisers to prey on our commerce, but they would not be sent through an American isthmian canal to do so.

Of the republics of South and Central America it may be said, first, that they do not possess sufficient naval strength to give us any concern, and, second, that their interests are so closely interwoven with ours that war between any of them and the United States is scarcely probable. But if it should occur, none of them would send their war ships through an isthmian canal. The greatest danger would be in the canal being damaged by a few men, and this danger would be greater if the canal were fortified than if it were neutral.

It is safe, therefore, to conclude that in a war between the United States and a nation of inferior naval power the canal would be of no value to our enemy, while a neutral canal would be as serviceable to the United States as one thoroughly fortified.

The nations that are approximately equal to the United States in naval strength are Russia, Germany, and Italy. Measured by tonnage the first of these has a navy about 25 per cent larger than that of the United States. But Russia is so situated geographically that operations against us could only be carried on at a disadvantage. She has a position at Vladivostock which is reported as being strongly fortified. It will soon have railroad connection with the capital of the Empire and will become an important base in the East. It lies uncomfortably close to the Philippine Islands, which are far removed from the support of the United States. The harbor of Vladivostock, however, is impaired by climatic conditions. The cold is so intense that the harbor is closed by ice for several months in the year. To reach the Philippine Islands and our commerce in the Pacific the Suez route for Russia is shorter, better, and less liable to interruption than one via an American isthmian canal.

The geographical position of Italy is not good for conducting hostile operations against the United States. In tonnage she is below, but in number of war vessels she is above the United States. She has an immense fleet of torpedo boats, a comparatively small number of fast cruisers, and is far behind the United States in modern-built ships. Some of her battle ships a few years ago were regarded as the most formidable afloat, as they carried the largest guns in existence. But these ships are not well adapted to operate at a long distance from a base.

It is difficult to see how Italy could do us much harm on the Atlantic side. A swift cruiser might capture some of our merchant vessels, but that Italy should contemplate sending a fleet through an American isthmian canal to the Pacific is preposterous. Should she make a naval demonstration in these waters it would be in the extreme western part, most probably in the vicinity of the Philippine Islands, and for this purpose the Suez route is shorter, safer, and in every way better.

Italy is more of a commercial nation than Russia, but her commerce does not amount to much, consisting chiefly of fishing vessels that never go far away from home. She has no important colonies. Those in Eastern Africa are not of sufficient importance to warrant the cost of an expedition for their capture, and their loss to Italy would not have an important influence on the war.

Germany and the United States are more nearly on an equality in naval strength than any other two important naval powers. In tonnage they are nearly equal; in modern-built ships the United States is ahead. Germany has, however, a great number of torpedo boats, and many of her cruisers are what are known as unprotected. The naval programme of Germany would make her the superior of France in fifteen years if the latter remain stationary. In other words, she would become in 1916 the second maritime power of the world, if her programme be carried out and the navies of other nations do not advance.

Germany, however, has no colonies or supply stations on the Atlantic side of the United States in close proximity on our shores. Her nearest colony is in Africa, too far removed to be of much use in a war with the United States, even if it were otherwise advantageous.

On the Pacific side Germany has supply stations, but they are few and far from the shores of the United States; but to attack us on that side, Germany would not use an American isthmian canal. The Suez route is better and less liable to be interrupted.

In the late war, Spain and the United States were generally considered to be approximately equal in naval strength, yet an isthmian canal, whether free or fortified, would not have rendered the results more decided nor have hastened the conclusion.

Neither Dewey's victory at Manila nor Sampson's at Santiago could have been made more complete by the existence of a canal; nor could the operations of our armies have been facilitated. The *Oregon* might have reached the scene of operations sooner, but that would not have helped matters, as the sequel proved. If the canal had been in existence and *partially* fortified, it would have been considered a vulnerable point of attack, particularly when Cervera's fleet was on the way across the ocean. A detachment of a part of our fleet to assist in the defense might have become necessary. In that case the blockade of Habana could not, in all probability, have been made effective.

In a war, then, between the United States and any nation of approximately equal naval strength the canal would not be used by our enemy, while a neutral canal would be as useful to the United States as a fortified one.

There are only two nations whose naval strength is decidedly superior to that of the United States; these are France and Great Britain. The total naval tonnage of the former is nearly double that of ours, but much of it is in vessels of an old type. Fort de France, on the island of Martinique, one of the Windward Islands on the east side of the Caribbean Sea, is a commodious, deep-water harbor. In old times it was a strongly fortified place, and is susceptible now of being made impregnable against naval attack. It affords a fine rendezvous for a French fleet within striking distance of the canal.

If the canal were fortified, France, under the laws of war, would have the right to capture, destroy, or blockade it if she could, but naval control of the Caribbean Sea would be necessary for its capture or blockade. Whether or not France would wish to do either would depend on circumstances. If she did, a struggle would necessarily take place for naval supremacy in the Caribbean Sea. But if the canal were neutral, France, without a violation of the laws of war, could neither blockade, destroy, nor capture it. She would therefore have less reason to strive for supremacy in the Caribbean, and the United States would get the full use of the canal without the necessity of fortifying it.

Would France wish to use the canal in case it were neutral and she became victorious in a combat on the Caribbean Sea? We think not. Her victorious fleets would undoubtedly have a short route to the Pacific coast, but she would not be likely to send them through it. If an accident happened to the canal while she depended on it as a part of her line of communication, her fleets would be placed in an awkward predicament. Moreover, there is better game on the eastern side more easily reached. On the other hand, if we became the victors in an engagement on the sea, the enemy's fleet would fall back on Martinique or recross the Atlantic; but it is not probable that a beaten French fleet would try to escape through an isthmian canal westward, even if it were freely open. In operating against the Philippines, France would use the Suez Canal.

Great Britain is by far the most formidable naval power in the world, whether measured by tonnage displacement, by number of ships, by weight of armor, or gun power. Her tonnage at the present time is nearly five times that of the United States and more than double that of any two nations of the world combined. Her ships are of the latest types, and the personnel of her fleet is in a high state of efficiency.

Great Britain is a commercial nation and dependent on the outside world for her subsistence. Her foremost object would be to keep open her avenues of trade, destroy everything that could threaten them, and render her adversary incapable of interfering with them. In a war with the United States her first aggressive operations would doubtless be on the Atlantic side, for which Great Britain is well provided with good bases in close proximity to our shore. Halifax is near our Northern coast, Bermuda is only about 800 miles east from Charleston, while the Bahamas and Kingston are close to the Southern coast. These stations form a cordon around our coast which would menace the operations of our Navy and from which Great Britain could operate against our coastwise commerce at her leisure.

If the canal were fortified, a garrison would be stationed there. To keep open communications between it and the United States would become a matter of the most vital concern. To destroy those communications would therefore be an object of the highest importance to Great Britain. She could afford to weaken herself temporarily at other points in order to accomplish this, and we would be compelled to concentrate the bulk of our Navy in the Caribbean Sea to maintain them. With five battle ships to our one, and with Kingston, a deep, well-fortified, and commodious harbor, as a base of operations, Great Britain would have every chance in her favor.

The Caribbean Sea would thus at first become the chief theater of war on the Atlantic side, and the canal itself a military outpost which could only be reenforced by troops conveyed to it by water. Now, a navy, to be efficient, must have freedom of action. If it be fettered with the task of keeping open this line of communications in the face of a powerful foe, its efficiency would be lowered, if not destroyed.

We could not depend on maintaining communications on the west side with our Pacific seaports. The line is too long and too easily broken. That Great Britain might eventually capture the canal is not beyond the range of possibility. The fact that it would be a most valuable prize, and its loss to the United States so detrimental to our interests as well as our prestige, would induce Great Britain to exert her utmost powers. If by any unfortunate circumstances adequate defenses or sufficient troops were not provided prior to the breaking out of war, the capture of the canal might become comparatively easy to a nation in control of the sea on each side.

An isthmian canal, to be of service to the United States, presupposes that passage to it, through it, and from it is assured.

But passage to or from it in case of war with a strong naval power could only be maintained by a strong naval force. If the canal bristled with guns from one end to the other it would be of no use to the United States while a powerful hostile fleet dominated the Caribbean Sea. The nation that controls the adjoining seas will in time of war control passage through the canal, no matter which one has possession.

The canal will be located in a region that is practically uninhabited. A few resolute men could disable it with little danger to themselves. This danger of being temporarily disabled is a serious one even in a war with a weak naval power. The destruction of a lock or embankment, which could be accomplished with a few pounds of dynamite, would bring about a total suspension of navigation for an indefinite period.

Suppose France owned, controlled, and managed the Suez Canal; what advantage would she derive from its being fortified in case of a war with Great Britain? Simply that of being able to deny its use to Great Britain—a negative benefit, the value of which is more than doubtful. The canal would become a military outpost impossible to reenforce unless the British Mediterranean fleet could be destroyed or evaded. The concentration of British fleets might be somewhat delayed, but that is all. The mere ability to force delay would not be decisive. Great Britain, in control of the Mediterranean and Red seas, would control the approaches, and, though she could not send her own fleets through it, she could effectually prevent France from reaching it. France would thus be placed in the position of holding a military station of no value to herself, that she could neither abandon without loss of prestige nor make her hold on secure by reenforcements.

The same would hold true with reference to an American isthmian canal in a war between United States and Great Britain. Perhaps Great Britain could not capture the canal. She might not wish to, but by blockading it she could destroy its usefulness to the United States.

From a military standpoint the canal is valuable only as a shortened line of communication. It has no other value. It does not serve as a good base of operations in a war with a strong naval power. It occupies no threatening position in a war with Great Britain. No prudent naval commander would hold a fleet in Lake Nicaragua or Lake Bohia to spring out on the foe in either ocean, as has sometimes been suggested. If our enemy be weak, it would not be necessary; if strong, the danger of being bottled up is too great. The canal is simply a link in the chain of communications. No chain is stronger than its weakest link. Forge it as you will, the weak link in a war with a stronger naval power than ourselves is on either side.

Munitions of war and troops would ordinarily be transported across the continent by rail, as that is a more expeditious route. As a line of communications it is badly located when considered in a war with a superior naval power. Instead of being in a protected position behind the main line of defense, it is out beyond the skirmish line.

An adequate defense of a fortified isthmian canal can be made in no other way than by providing a navy of sufficient power to control the seas at either terminus. With such a navy at our command the canal needs no fortifications. What number of battle ships, cruisers, etc., would be necessary to accomplish this end we do not feel competent to estimate ; that is a question for naval experts to determine.

Suppose, on the other hand, the canal were neutral. It would not then become a prize of war. Neither the maintenance of an army to protect it nor of a fleet to keep open communications with it would be necessary. Great Britain might possibly send ships through it, but even that is doubtful. The most that could be gained by doing so is a saving of time. Under some circumstances this might be an important matter, but the naval preponderance of Great Britain is such that time would be of less importance to her than to us. It is scarcely probable that it would ever be so important to her as to justify her in taking the risks of sending a fleet through a canal under American control.

The canal is of more value to the United States than to any other nation. To keep it and the approaches open at all times would therefore be the aim of our Government. But no amount of fortifications along the line of the canal would afford safe passage to a ship across the Caribbean Sea.

It is believed, in consideration of the freedom of the canal extended by the United States to the ships of all nations, those nations would agree to an arrangement by which the region of the canal and large areas of the sea at each terminus should be exempted from the operations of war. The larger these areas of neutrality the better. But in view of the benefits to mankind which the United States would confer by the construction of the canal, there ought to be no serious difficulty in securing areas of the sea bounded by arcs of circles described with radii of, say, 100 miles or more.

Should such an agreement be violated by any nation that is a party to it, the United States could destroy the canal, if necessary, so as to render it impossible of being used against it. As no nation except Great Britain would wish to use the canal for other than peaceful purposes of commerce, and as she probably would have no strong reason for using it in any other way, it is not seen why such an agreement might not be made. How such a status of the canal and adjacent waters can be effected are matters for statecraft to settle. The object of the foregoing remarks is to show that a neutral canal with a large area of neutral waters at each terminus is, in the existing status of the naval powers of the world, a more useful canal to the United States from a military standpoint than one that is controlled by military power.

THE 16-INCH BREECH-LOADING RIFLE,
TYPE, MODEL 1895.*

REPORT BY COLONEL J. P. FARLEY, ORDNANCE DEPARTMENT, UNITED STATES ARMY, DATED WATERLVLIET ARSENAL, WATERVLIET, N. Y., SEPTEMBER 15, 1900.

NOTES ON THE CONSTRUCTION OF ORDNANCE.

Washington, November 27, 1900.

I.

The 16-inch B. L. rifle, a type gun, is the first of a series of similar gigantic weapons which were constructed for the seacoast defense of the United States. The Endicott Board, which had the whole subject of seacoast defense under consideration some years ago, reached the conclusion that eighteen of these weapons should be provided for the protection of New York. The Board also recommended that ten 16 inch guns should be mounted at San Francisco, eight at Boston, and four at Hampton Roads.

Other rifled guns of large caliber heretofore constructed are the Italian gun, caliber 17.76 inches, the French gun of 16.5-inch caliber, and the Armstrong gun of 16.25-inch caliber, which is carried on the battle ships *Benbow* and *Sans Pareil.* Not one of these compares, in point of energy and range, with the 16-inch gun, the manufacture of which is nearing completion at the Watervliet Arsenal Gun Factory, New York.

The range and energy of this latter gun will, of course, vary with the quality and amount of powder used, and the question of the actual performance of the gun can therefore only be determined by actual trial tests. With smokeless powder as at present proposed, the gun requires a powder charge of 576 pounds, but if the old black powder is used, 1,176 pounds will be required. With a maximum powder pressure of between 37,000 and 38,000 pounds to the square inch, it is estimated that the gun will throw a projectile weighing 2,370 pounds with a muzzle velocity of 2,300 feet per second, developing a muzzle energy of 88,000 foot-tons: but it is not improbable that by using a slower-burning powder, giving a less maximum pressure (these being the qualities constantly sought for in the manufacture of smokeless powder), the gun would develop even greater velocity and energy than this, with a relatively small increase in the chamber pressure. Even on the basis given above, however, this gun shows an enormous superiority to any of the large guns above mentioned. The Italian gun, for instance, throws a projectile weighing 2,000 pounds with a muzzle velocity of 1,700 feet per second, and an energy of only 40,000 foot-tons, an energy considerably less than one-half that of the new army gun ; the French gun projectile, weighing 1,700 pounds, with a muzzle velocity of 1,700 feet per second, developed a maximum energy of 36,000 foot-tons ; while the English gun projectile, weighing 1,800 pounds, with a muzzle velocity of 2,100 feet per second, showed a total energy of 51,000 foot-tons. The maximum energy of the Italian gun was thus 45 per cent, the French gun 41 per cent, and the English gun 65 per cent that of the Watervliet Arsenal gun. The projectile of the gun will be 5 feet 4 inches in length, and the penetration in steel at the muzzle corresponding to the energy given above is (De Marre's formula normal impact) 42.3 inches.

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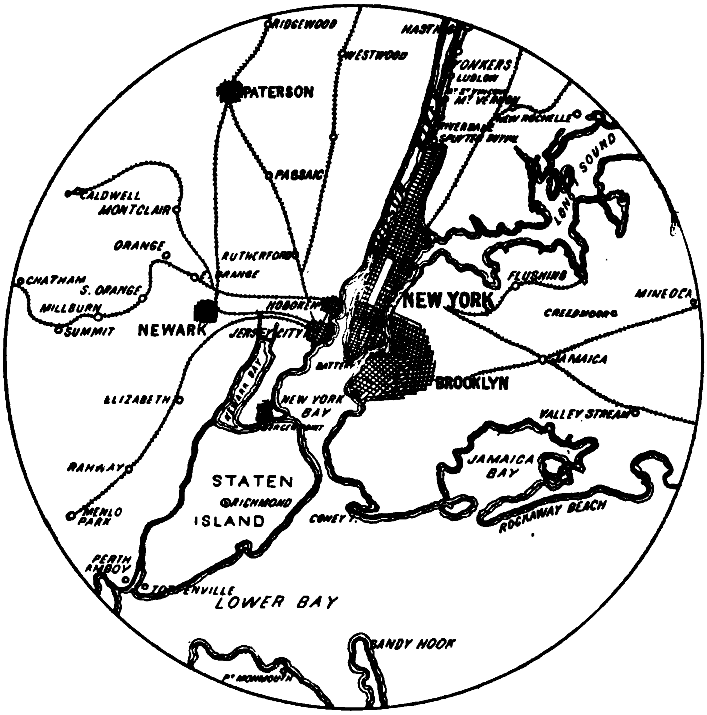
* Reprinted by permission of the Chief of Ordnance, U. S. Army, who also very kindly loaned us most of the plates.—ED.

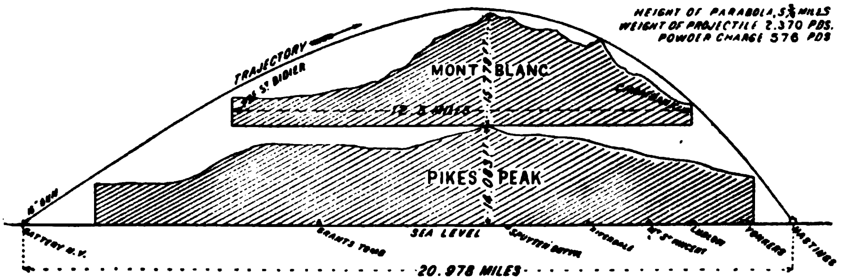
Undoubtedly the most spectacular feature in connection with this gun is its enormous range, which is estimated at about 21 miles, or, to be exact, 20.978 miles. This theoretical range has been calculated by Major James M. Ingalls, 5th U. S. Artillery, for many years instructor at the Artillery School for Officers at Fort Monroe, Va. A firing table for this gun prepared by Major Ingalls shows that the above range is obtainable with a muzzle velocity of 2,300 feet per second, with the necessary angle of elevation of the piece. The trajectory of the projectile shows that in ranging to 20.978 miles the shell would reach the maximum elevation of 30,516 feet. This is enormously greater than the muximum range hitherto obtained by any other gun which at present stands to the credit of a Krupp 9.45-inch gun, which was fired on the Meppen range, in the presence of the Emperor of Germany, on April 28, 1892. The measured range was found to be 22,120 yards, or, roughly speaking 12½ miles. The greatest height reached by the Krupp shell in its flight was 21,456 feet, and the time occupied between the firing of the gun and the striking of the projectile was 70.2 seconds. It was pointed out that had this gun been placed at Pre St. Didier, in the Alps, elevated to 44°, and fired, its shell would have ranged 8,956.8 feet higher than Mount Blanc, and its fall would have been in the neighborhood of Chamounix, on the other side of the range. This performance, great as it was, becomes positively insignificant compared with the capabilities of the new army gun. To show what the 16-inch gun can accomplish, the accompanying map and diagram has been derived from a late issue of the Scientific American. In the map of New York and vicinity the gun is supposed to be set up at the Battery. With a radius of 20.978 miles a circle is struck, inclosing the territory that would be reached by the projectile of the huge weapon. Pointed to the north, the gun would throw its shells as far as New Rochelle on the Sound, and Tuckahoe would be easily within range, as would be Hastings-on-the-Hudson. The circle inclosing its zone of fire would pass through Hempstead and Long Beach, on Long Island, and its shells would pass far above Staten Island and fall half a mile beyond the Atlantic Highlands; Keyport and Perth Amboy would be open to attack, as would Westfield and Milburn in New Jersey, while the residents of Montclair could hear the huge projectiles roaring high overhead, to fall 3 miles distant in the valley beyond; Patterson would be within reach with 4 miles to spare, and Ridgewood would be an easy mark.



Adopting the method pursued by the German artillerists to give a graphic picture representative of the range, the Scientific American also prepared the accompanying profile showing Pike's Peak, Colorado, with Mount Blanc superposed above it, the combined height of the two mountains being 29,926 feet. As the extreme height of the trajectory of the 16-inch gun is 30,516 feet, or above 5¾ miles, it will be seen that it would rise higher than the combined height of these two mountains by 590 feet. On the the base line of the profile are marked various well-known localities between a line on the Battery to Hastings-on-the-Hudson, with the distance shown in miles.

In introducing the general substance of the article which appeared in the Scientific American as a foot-note* to this paper, it is but proper to add the following:

"By the courtesy of the War Office, under authority given Colonel J. P. Farley, of the Ordnance Corps, commanding the Watervliet Arsenal, New York, we are enabled to present three very interesting photograps showing the gun in the boring lathe, the handling of the jacket preliminary to its being shrunk on to the tube, and the lowering of the gun into the shrinkage pit to receive the locking or "D" hoop. At our request, this officer has also furnished us data from published official records relating to the oil and steam furnace and to the operation of the shrinkage of the gun jacket."



Much of the matter, therefore, which appeared in the paper referred to and which is here repeated, was furnished the editor of that journal under instructions from the Chief of Ordnance, U. S. A., and was compiled in the course of preparation of this official report.

DESCRIPTION OF GUN.

The total length of this gun is 590.9 inches (49 feet 2.9 inches), with a diameter of the rear portion of 60 inches, the forward part gradually diminishing from 60 inches to 28 inches at the muzzle.

The length of main bore is 448.5 inches (37 feet 4.5 inches), with a diameter of 16 inches; the cylindrical part of the powder chamber is 90.7 inches long, with a diameter of 18.9 inches; this is connected with the main bore by a conical slope 24 inches long. The volume of the powder chamber is 29,385 cubic inches. The main bore will be rifled, having 96 lands and 96 grooves; the depth of each groove is 0.06 of an inch; the rifling curve is of increasing twist, being a semicubic parabola, starting with one turn in 50 calibers, gradually increasing to one turn in 25 calibers at the muzzle.

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* This introductory part is a foot-note in the original.

The breech recess, containing the threaded and slotted portion for the locking of the breechblock, is 24.4 inches long, with a diameter of top of threads 24.86 inches.

The gun is built up of the following parts:

A *tube*, 566.5 inches long, with a maximum outside diameter of 29.3 inches; *two C hoops*, which are shrunk over the tube from the forward end of the jacket to the muzzle.

The *jacket* is 304.65 inches long, and is shrunk on the rear portion of the tube from the end of the C hoop; the rear end of the jacket, for a length of 24.4 inches, overhangs the tube and forms the breech recess.

The *D hoop*, which is 144.5 inches long, is shrunk over the forward end of the jacket, and rear part of the C hoop; its bore contains two locking shoulders, which grip over two corresponding shoulders on the jacket and C hoop, thus interlocking the whole system, and preventing any possible sliding backward of the jacket or sliding forward of the C hoops, due to the shock of firing.

Three A hoops are next shrunk on; the A 1 hoop overlaps the rear part of the D hoop with its front end, and the outer surface of the jacket with its rear end; the hoops A 2 and A 3 are shrunk directly over the outer surface of the jacket.

The *B hoops*, which are not yet assembled, will be shrunk outside of the A hoops. The shape and dimensions of the forward B hoop will depend entirely upon the mount to be used for this gun, a matter which has, as yet, not been definitely determined.*

Pending this decision, and in order to save time, the gun is now being preliminarily finish-bored, leaving sufficient stock for the final finish bore which will be taken after the B hoops are assembled.

The weights of the different parts of the gun in their rough and finished condition are as follows:

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* There has been a trunnion hoop furnished for this gun, to adapt it to a Buffington disappearing carriage. A model gun one-tenth size is now being manufactured at this arsenal, and a model carriage on the same scale is being also manufactured here for preliminary tests.

ROUGH WEIGHTS.

	Pounds.
Tube	84,556
Jacket	90,058
Hoop C 1	23,525
Hoop C 2	16,270
Hoop D	26,925
Hoop A 1	19,859
Hoop A 2	16,137
Hoop A 3	20,163
Hoop B	....
Hoop B 1	13,074
Hoop B 2	22,773
Hoop B 3	22,773

FINISHED WEIGHTS.

Tube with C hoops	100,260
Jacket	73,900
Hoop D	23,900
Hoop A 1	14,910
Hoop A 2	15,120
Hoop A 3	19,940
Hoop B	Only partly finished; awaiting decision as to carriage.*
Hoop B 1	
Hoop B 2	
Hoop B 3	

DESCRIPTION OF BREECH MECHANISM.

The breech machanism for this gun is denominated the "Stockett system," a modification and simplification of the Farcot-Fletcher system, and consists of the following principal parts:

Breechblock.
Consol or tray with latch.
Hinge plate.
Obturator spindle with appurtenances.
Compound gear.
Worm wheel.
Worm with worm shaft, rotating crank and handle.

The breechblock has a diameter of 26 inches, and a total length of 27.3 inches, with a length over the threaded portion of 19.89 inches. The threaded portion is divided into twelve sectors, six threaded and six blank, each sector being 30°, corresponding to similar sectors in the breech recess of the gun. The pitch of the thread is 1.71 inches; on the rear end of the breechblock is a projection where the rotating rack is cut; the teeth of this rack have a normal pitch of 1.50 inches, and a circular pitch of 1.577 inches; the longitudinal thread of these teeth is one turn in 248.25 inches.

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* These hoops with the trunnion hoop are being finished for assembling, now that a decision relative to the carriage has been reached, the carriage being of the disappearing type.

The block is bored out and recessed for spindle, nuts, etc. The translating rack is cut on the right-hand side of the block; the pitch of the teeth of this rack is 2.426 inches; the depth of the teeth is 1.11 inches.

Both the rotating and the translating racks are cut out of the solid block.

The consol or tray is a steel casting. The guide rails are flat, and have a length of 16 inches. The distance from center of tray to center of hinge lug is 15.70 inches, and the height of hinge lug, 15.55 inches.

The tray latch is pivoted underneath the tray and is arranged so as to open and close automatically.

The hinge plate is fitted into and bolted to a recess in the breech end on the right side of the gun, and has two heavy lugs for the hinge pin; these lugs are located far enough apart to admit the hinge lug of the tray, and also the compound gear; underneath the bottom lug is a recess containing the worm and worm shaft.

The obturator spindle has a total length of 26.95 inches. The mushroom head has a diameter of 18.05 inches, and a thickness of 4 inches. The forward part of the spindle has a diameter of 6.22 inches, and the rear part, 5.97 inches. The end of the spindle is threaded with a left-hand thread for the obturator nut, the spindle is drilled with a 0.2 inch vent hole, and the end threaded and bored for regular obturating primers; the dimensions of the rear end, however, are so large as to permit of any change it might be necessary to make when a firing mechanism for seacoast guns has been finally determined upon.

The gas-check pad. front, rear and small split rings, are the same style as those used for all other seacoast guns at present.

The compound gear, so-called because the teeth are so arranged as to perform both the rotation and translation of the breechblock, has an outside diameter of 8.785 inches, and a thickness of 3.8 inches; the spiral teeth (for rotation of block) have the same normal pitch (1.50 inches) as the rotating rack on end of breechblock, but with a circular pitch of 4.854 inches, and a thread pitch of one turn in 7.885 inches; the angle of this pitch is 18 degrees.

The translating teeth are formed by slotting the spiral teeth vertically; the number of these teeth is ten, with a circular pitch of 2.426 inches. The compound gear is bored to a diameter of 3 inches, and slotted with two keyways, which bore and keyways fit corresponding parts on the hinge pin.

The worm wheel is made of hard bronze, and has a maximum outside diameter of 10.165 inches, and a thickness of 2 inches.

The worm (made of steel) and the bronze worm wheel are cut according to the Hindley system, giving the maximum amount of bearing surface; the number of teeth on worm wheel is 24, with a pitch diameter of 9.071 inches, with their circular pitch cut to fit a double threaded left-hand worm, having a pitch of 2.375 inches, giving a ratio of 12 to 1.

The worm shaft is an extension of the worm, and is in one piece with the same. On the end of this is the rotating crank, which is 15 inches from center to center, with a handle 16 inches long.

The worm, with shaft, is placed in the recess provided for it in the hinge plate, and has hardened steel ball bearings at each end of this recess, to take up the thrust due to rotation, and reduce the friction to a minimum.

OPERATION OF THE BREECH MECHANISM.

This mechanism is so designed as to be opened or closed with one continuous motion of the rotating crank; twenty-two and one-half revolutions in one direction open the mechanism, and the same number of revolutions in the opposite direction will close it.

In manipulating the crank, the worm transmits the motion to the worm wheel and the compound gear, both of which are fastened to the hinge pin; the spiral teeth of the compound gear being engaged in the teeth of the rotating rack, rotates the breechblock. The rotation of the breechblock is limited to the proper amount by a projection on the lower end of the rotating rack striking against the underside of the compound gear, and the translating teeth of this gear are now brought into action with the teeth of the translating rack of the breechblock, withdrawing this out on the consol or tray, the block being guided and supported by the guide rails of the tray engaging into the guide grooves of the block; the amount of translation is limited by the ends of the guide grooves abutting against the forward end of the guide rails. At this point, the tray latch, which has been engaged with its forward end in the tray latch catch holding the tray firmly up against the end of the gun, is being tripped by the rear end of the block, thus releasing the tray from the gun, and by the continued motion of the rotating crank, the combined breechblock and tray are swung around the hinge pin over an arc of 123°, leaving the breech of the gun fully open for loading. In closing the mechanism, by rotating the crank in the opposite direction, the different motions of the block will take place in the reverse order of those described for the opening of the mechanism.

GAS CHECK.

The plastic pad gas check is the system of obturation adopted for the 16-inch gun.

CRANE ATTACHMENT.

The device shown in accompanying sketch was designed by the master mechanic at the Watervliet Arsenal to be attached to the larger crane for the transportation of the 16-inch 130-ton gun, to and from the shrinkage pit, in the operations of hoop and jacket assembling, as well as to and from the lathes, threading, slotting, and rifling machines, after assembling.

The design provides for the suspension of the gun by four steel-wire slings, each pair of slings being attached, by heavy hooks, to the end of beams pivoted in the middle on pins and secured to the lower corners of a triangular frame. This triangular frame is suspended at its upper corner by a bail, which goes through the main hoisting eye of the crane.

A model of this device was at first constructed together with a wooden model of the 16-inch gun, as originally designed, but owing to the fact that the new center rail of the crane way was not in readiness, the device itself was not completed, since the transportation of the gun on a single crane (with short wheel base) would have made it insecure on the unaltered crane way.

For this reason, two cranes, each with two slings applied at each end of the gun, have been used, in lieu of the proposed device with one crane, as the combination of the two cranes provided sufficient wheel base for the unaltered crane way.

The "attachment to the crane" provided, as is shown in the sketch, for a number of slings, the same as are used in handling or transporting the 12-inch rifle, thus avoiding the necessity for the use of a less number of stouter or more bulky slings had but a single crane been employed without the proposed device.

Since four slings can not be of exactly the same length, the pivoted beams are arranged to equalize the weight and thus prevent undue strain on the flexible members of the system. The limit of hoist and available space has been provided for in the construction of the crane attachment, and the partly assembled

TO ACCOMPANY CONSTRUCTION NOTES No. 72.

Attachment for 120 ton Crane.

for the transportation of 16 inch Rifles in the shop

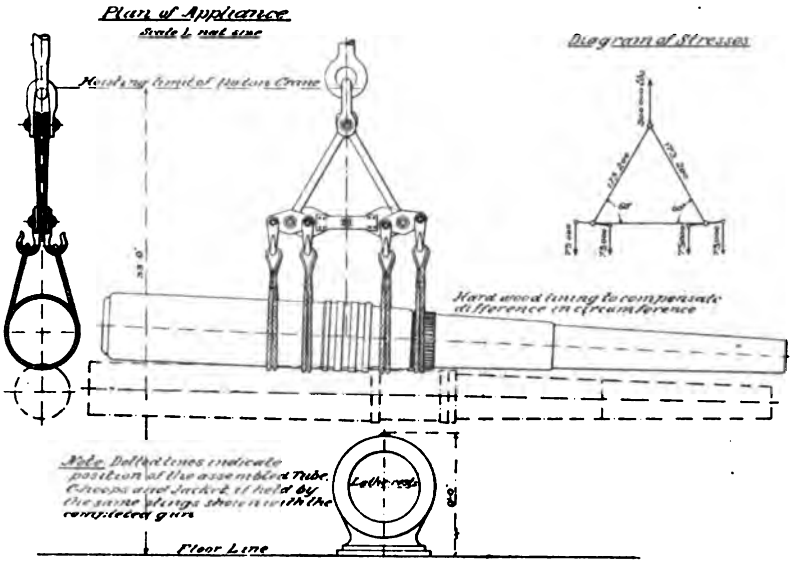
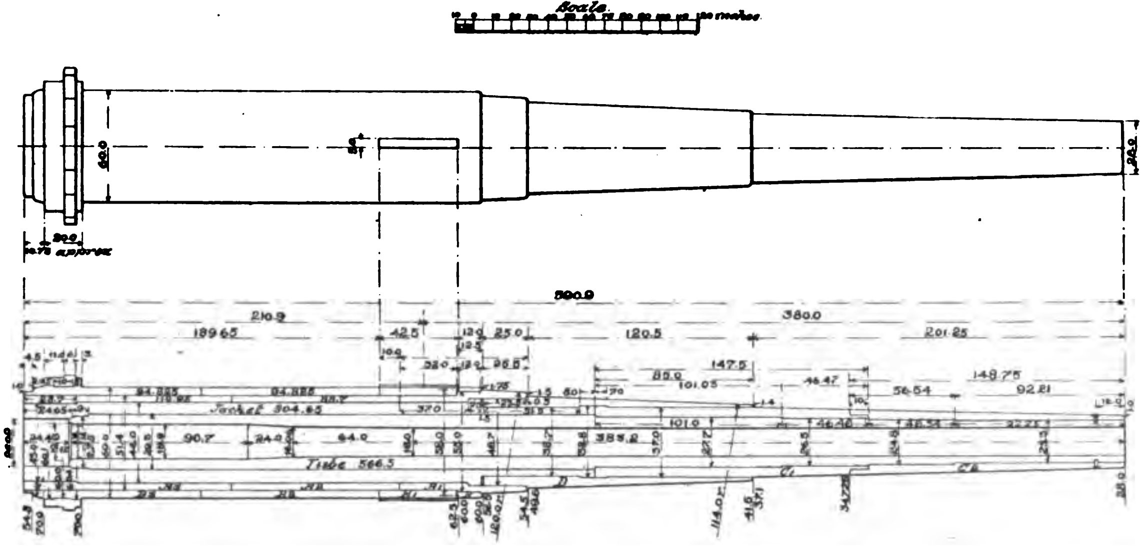

Plan of Appliance
Scale 1 nat size
Hoisting limit of 120 ton Crane
Diagram of Stresses
173 200
173 200
60°
60°
75 000
75 000
75 000
75 000
Hard wood lining to compensate difference in circumference
Note. Dotted lines indicate position of the assembled Tube, C-hoops and Jacket, if held by the same slings shown with the completed gun
Lathe rests
Floor Line

Plate I.

Copied from O.O. Drawing of Aug 28, 1899.

TO ACCOMPANY CONSTRUCTION NOTES No. 78.

16 INCH B. L. RIFLE, STEEL, 130 TONS, MODEL 1895.



gun, with the smallest diameters and longest reach of slings, can pass over the highest projection on the floor line of any part of the gun lathes.

NOTE.—The composite photographic plate showing the 16-inch B. L. rifle, the 300-pounder 10-inch Parrott rifle of 1863, and the 20-inch Rodman smoothbore of 1864, has been made up from the original model of the first-named gun and photographs of the other guns all brought to same scale. The model 16-inch gun as shown in the photograph will be changed in the matter of trunnion hoops, to adapt the gun to the Buffington disappearing carriage now being constructed at the Watertown Arsenal, Mass. The 20-inch Rodman smoothbore is shown as it now appears at Fort Hamilton, New York Harbor.

The 20-inch caliber Rodman gun shown in the photograph is the first one of the size ever constructed, and is built upon the same lines as the Rodman smoothbores of lesser calibers, such as the 8-inch, 10-inch, and 15-inch, which class of guns were employed in our seacoast defense during and for many years after the war of the rebellion.

The gun is 20 feet long, 64 inches in diameter, and weighs about 116,000 pounds, and is one of the largest cast-iron guns ever made. It was cast at Pittsburg in 1864, and one other gun of the same dimensions was made there later. It has never been at any other post than Fort Hamilton, N. Y., and has been dismounted for ten years from its carriage.

The photograph also shows the 300-pounder 10-inch Parrot rifle, the only one of this caliber ever constructed. It resembles in its proportions the lesser calibers, 100 and 200 pounder Parrott rifles, which were in general service during the war of the rebellion.

This particular gun was the most prominent one of the group of so-called "Swamp Angels," used in the batteries before Forts Wagner and Sumter in the siege of Charleston, 1863-64. The muzzle of this gun is shown to have been carried away, with an irregular fracture, by the premature explosion of a shell.

This irregularity so deflected the projectile that it became necessary to chip it off to an even bearing for the projectile as it left the bore.

To accomplish this, it was necessary to call for a mechanic who would volunteer to sit astride of the gun, within easy range of the enemy's batteries, and do the work under a constant fire of artillery and sharpshooters, night and day.

In recording this incident, the writer feels that whilst the gun as represented in its wrecked condition serves as a reminder of what at the time (1863) was regarded as "an enormous rifle," yet this instance of exceptional valor is, even in this connection, worthy of note.

REPORT ON CONSTRUCTION.

Estimates were made as early as the year 1891 by the Chief of Ordnance, U. S. A., to procure the necessary machines, tools, and fixtures for an output of three 16-inch caliber guns per annum, each of which should weigh, as originally designed, 126 tons.

Later the design was modified to accord with the accompanying diagram, Plate I. The completed gun in the latter case to weigh 130 tons, from forgings in the rough weighing 375 tons.

An estimate was made in 1892 for forgings for the 16-inch type gun.

The necessary tools, machines, and fixtures were contracted for in 1894, which provided for three boring and turning lathes designed at this arsenal and manufactured by the Pond Machine Tool Company, New Jersey.

These lathes were 138 feet in length, with a swing of 9 feet, and each one weighed 280 tons, requiring for its transportation to the Gun Factory at Watervliet, N. Y., sixteen separate cars. The bed of the lathe was built in six separate sections.

A turning lathe for the gun, and one for the jacket, were also purchased, but the former was found to be unnecessary for this purpose, as one of the 12-inch gun lathes was used in its stead, and since its purchase this lathe has been fitted up for 12-inch jacket work, for which it is well adapted.

The rifling machine for the 12-inch guns was extended in length and fitted for rifling the 16-inch gun.

There were also purchased an extra slotting and threading machine, and a 150-ton traveling crane, the latter from the Morgan Engineering Company, Alliance, Ohio. The factor of safety of this crane is six, but this is reduced to five on account of its chain; it will, however, carry 120 tons with this large safety factor. The chain originally designed for this crane, but not furnished, would have provided for the handling of 150 tons, with a safety factor somewhat greater than that specified.

This crane is equipped with one Thomson & Houston shunt-wound motor, originally wound for 500 volts. Since this crane was installed, the motor has been changed to 220 volts—that is, armature rewound for 220 volts and shunt windings on fields connected in multiple instead of series. This motor runs at a speed of about 1,000 revolutions per minute, requiring about 80 amperes when under full load. The different movements of this crane are controlled by shafting geared to motor, one motor doing all the work. The power to operate motor is taken from six single wires, about 00 size, lying alongside and on each side of crane track, being stretched and held in place by long composition rods, threaded on one end, fastened to each wire, and set up with nuts on each end of wire.

On June 6, 1896, an appropriation was made for the construction of the 16-inch type gun, and on December 30, 1896, the contract for one set of 16-inch forgings was let to the Bethlehem Steel Company, to be delivered within eighteen months. The tube, jacket, and breechblock were to be of nickel steel.

Instructions for the manufacture of the type 16-inch rifle were dated January 26, 1897, and this was followed by an order, dated February 7, 1897, directing the manufacture of a breechblock, console, etc., to be fitted to a 15-inch Rodman smoothbore gun, in order to test the adaptability of this mechanism on a scale as large as that reqired.

The breechblock in this case was made of cast iron simply, as a working model; the other parts of the breech mechanism, already fitted and made of the regular material, will be used with the gun when completed. This mechanism is operated by one-man power at the crank handle and with great facility.

The first forging for the 16-inch gun was received on February 19, 1898; the other forgings followed from time to time, till August 2, when the last one, the D hoop, was received.

The other guns in hand being more urgently demanded, work on these forgings was not commenced till May 14, 1898, when the tube was placed in the lathe. The time of boring this with the first tool was 424 hours, and with the second, 96 hours, making 520 hours for the rough boring.

On September 1, 1898, the condition of work on the forgings for the 16-inch gun was as follows:

Tube—first and second rough-bored and rough-turned.
Jacket—rough-turned, first rough-boring about half completed.
Hoop C 1—finish-bored, ready for lip.
Hoop C 2—finish-bored, lip in progress.
Hoop D—spotted for boring.
Hoop A 1—rough-turned, spotted for boring.
Hoops A 2 and A 3—spotted for boring.
Hoops B 1 and B 2—spotted for boring.
Hoop B 2—no work done.

Following this work, the C 1 and C 2 hoops were turned and fitten for shrinkage on the tube which was prepared to receive them, and this operation having been accomplished without difficulty, the shrinkage of the jacket was held over until the completion of the special furnace proposed for this purpose.

MACHINE TOOLS, BORING TOOLS, AND OTHER APPLIANCES.

By way of recapitulation, and with a fuller description of the minor tools used in the manufacture of the gun, the following data have been derived from Mr. A. Christiansen's memoranda.

At the time the 16-inch gun was designed, it was expected by the Ordnance Department that a large number of guns of this character would be built; a sufficient number of machine tools were therefore procured and installed in order to meet promptly any demand that might be made on the Gun Factory for this class of ordnance; having had thus far only one 16-inch gun to build, the majority of these heavy and costly machines have not been in use for the manufacture of this gun. It should, however, be stated that these tools can be adapted for the manufacture of 12-inch guns in case the demand for these guns and the supply of forgings should exceed the capacity of the present 12-inch plant.

The machines procured for the manufacture of 16-inch guns are as follows:

(1) Three boring and turning lathes.
(2) One turning and finishing lathe.
(3) One jacket lathe.
(4) One threading and slotting machine.
(5) One 60-inch hoop lathe.
(6) Two 84-inch hoop lathes.
(7) The extension of 12-inch rifling machine, adapting it for 16-inch guns.

All the above machines were designed at the Army Gun Factory, and built by the Pond Machine Tool Company, of Plainfield, N. J.

(8) One 18-inch slotting machine.
(9) One 72-inch vertical boring machine.
(10) One horizontal boring, drilling, and milling machine.

These last three machines are of commercial patterns, and were built by the Niles Tool Works, Hamilton, Ohio.

(11) One 150-ton electric traveling crane.

Built by the Morgan Engineering Company, Alliance, Ohio.

Of all these machines, only the following have been or will be used for this type gun, but other tools will be utilized should additional guns be ordered manufactured:

One boring and turning lathe, including foundations, shafting, etc.
One 84-inch hoop lathe.
One altered 12-inch rifling machine.
One threading and slotting machine.
One 150-ton crane.

The special tools for boring of tube, jacket, and hoops were manufactured at the Gun Factory, and used for boring the different pieces preparatory to assembling:

For tube—One hognose, one wood-packed reamer.
For jacket—One hognose, two wood-packed reamers.
For C hoops—Four hognoses, four wood-packed reamers.

For boring the other hoops, cutter heads and tools of the ordinary kind already on hand were used. Other cutter heads, already made or under manufacture for use after assembling, are as follows:

One wood-packed reamer for finish-boring of main bore.
Two hognoses and one reamer for boring of powder chamber.

One reamer for boring of gas-check seat.

Two reamers for boring of conical slope connecting main bore with powder chamber.

One rifling head.

One threading head for the threading of breech recess.

One slotting head for slotting of breech recess.

One reamer for boring of forcing slope.

For finish-turning of gun, ordinary turning tools on hand will be used.

Besides the machines and tools above mentioned for work on the gun before and after assembling, the following preparations were made for the assembling of the gun :

The deepening of the shrinkage pit by 10 feet, making the total depth about 60 feet. This was necessitated by the great length of the 16-inch gun ; the original depth of the pit in addition to the height of crane hoist above the floor line being only sufficient to accommodate 12-inch guns.

A heavy cast-iron chuck was made and securely anchored in the bottom of the pit, and an intermediate chuck placed some feet above this, to give a firm and steady support to the gun during the shrinkage operations.

A heavy "tipping-rest" was constructed and placed at the proper height for supporting the lower end of the gun while it was resting in an angular position in order to place it in the above-mentioned chucks.

For handling the gun in the shrinkage pit two heavy steel plugs were fitted into the bore of the tube and connected with a rod 7 inches in diameter screwed into these plugs; the plug in the upper end being arranged so as to connect with the bail on the crane-hook.

Heavy steel straps and special hoisting appliances were made for jacket and hoops ; the forgings for plugs, hoisting rod, straps, etc., were made at Watertown Arsenal. The aggregate weight of all these parts was about 37,000 pounds.

A heating furnace of sufficient capacity for the jacket and hoops was constructed, as is further on described.

OIL AND HIGH-PRESSURE STEAM SHRINKAGE FURNACE.

The new oil-burning high-pressure steam shrinkage furnace has been put in successful operation.

The steam pipes leading to the same and throughout the shops were covered with magnesia and asbestos cloth ; separators and a steam superheater have been provided.

The wet steam or water coming over with the steam was the principal source of difficulty, and there was besides a great deal of condensation due to the exposed steam pipes about the furnace. Experiments with different forms of burners also showed that great care must be taken to provide an exact ratio of oil and steam issuing from the burners.

Experience in manipulating the furnace shows a reduction in time of heating for 10 and 12 inch jackets from two days to five or six hours.

The examinations to determine that the forgings are evenly heated have been reduced from nine, in the first instance, to two hours.

In the Annual Report of the Chief of Ordnance for 1895, page 120, referring to the subject of annealing cartridge cases at the Frankford Arsenal for field and siege guns, it is stated that "annealing this metal (aluminium) is a delicate and uncertain operation, the limits of temperature within which results are satisfactory being relatively close. For this lot the annealing has been done by hand, the case being held in the flame until the temperature was thought to be right."

Much diffiulty was experienced in obtaining suitable annealing furnaces for the above operation, and it was only after diligent inquiry* that the oil and high-pressure steam principle was determined to be practicable for the purpose. Since that period, following the plan of W. S. Rockwell & Co., New York City, these furnaces have been successfully introduced on a large scale at the Frankford Arsenal, and the same principle has also been applied with success at this arsenal for shrinkage purposes in the field and siege gun shops. In fact, it has so admirably fulfilled expectations that the furnace devised by and constructed by Mr. Alfred Christiansen, master mechanic at this arsenal, on this principle, is the one upon which reliance has been placed for the shrinkage of the large masses on the 16-inch gun.

The furnace consists of a vertical cylindrical 13-inch fire-brick wall resting upon solid rock in the southeast corner of the shrinkage pit (Plate I). Being upon the 30-foot level and 27 feet 9 inches high, its top is 2 feet 3 inches below the floor level. Fuel oil is supplied through a 3-inch pipe from a 5,000-gallon tank upon the hill, and enters the furnace through twenty burner openings in five tiers of four burners each. The burner consists of an oil pipe with a small steam pipe inside and in the inner end of each pipe is a small hole.

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* By the then commanding officer, the writer of this paper.

The steam, issuing with high velocity through the small opening in the end of the pipe, carries the oil with it as a spray, and its oxygen, combining with the oil, gives an exceedingly hot flame. The direction in which the burner points may be slightly varied by bolts and nuts, two pieces thereof forming a kind of ball-and-socket joint of limited motion. To prevent the hoops being excessively heated where the flames would impinge, causing unequal expansion and even affecting injuriously the physical properties of the metal, a muffle or cylinder of ½-inch boiler steel surrounds the hoop to be heated, and prevents actual contact of the burning gases with it. This muffle transmits the heat, and circulation of the air inside the muffle tends to make the heat at all points equal. The furnace has a removable steam cover to confine the heat and gases. The gaseous products of combustion are drawn off through the flue, connecting with the main chimney flue. A damper is available for holding back the gases until they have imparted to the work as much of their heat as may be desired.

The temperature in the furnace may be partially controlled thus, and is also governed by the number of jets burning and by the adjustment of the amount of oil and steam admitted. For this last purpose there are valves upon the oil and steam pipes entering each burner. In order to observe the flame and determine if it is burning properly, each burner is surmounted by an observation opening through the brick wall, closed by a mica door.

The uniformity of heating, which is most important, is one reason for the tangential direction in which the burners enter the combustion chamber, causing a rapid spiral motion of the burning gases about the muffle.

The circular pipes supplying the burners are connected with the main oil and steam pipes.

HEATING THE JACKET OF THE 16-INCH B. L. RIFLE FOR ASSEMBLING.

This operation has necessarily awaited the completion of this furnace, there being none other here large enough to hold the jacket, and has also been delayed by the nonarrival of forgings for the various appliances required to handle this enormous piece with safety and accuracy. The forgings are now on hand, and the machine work upon them nearly completed. The 16-inch gun was ready for its first shrinkage, that of the C hoops, in October, 1898, but the operation was postponed on account of more urgent work, as well as on account of the lack of proper appliances for handling. The C hoops were successfully assembled, however, April 6 and 7, 1899, using a makeshift method of handling by lashings of chains and ropes. The tube alone, as tipped from the horizontal to the vertical position and lowered into the pit, weighed about 65,000 pounds. The tube with its assembled C hoops, as it was lifted from the pit and tipped back to the horizontal, weighed 120,000 pounds. The C hoops were heated for shrinkage in the old coal-burning shrinkage furnace.

The most tedious parts of the whole work were probably the last stages in the building of the furnace and learning to operate it satisfactorily. During these operations the developments as to the various things needed in connection with its construction came one by one, and the procurement of each one of these consumed a great deal of time.

The principal difficulty met with in operating the furnace was wet steam. The furnace being so low, besides at some distance from the boilers, it was found that considerable water came over with the steam, and there was besides a great deal of condensation due to the exposed steam pipes about the furnace. The first step taken, therefore, was to cover all the steam pipes leading to the furnace with magnesia covering and all the steam pipes about the furnace itself with asbestos cloth. This not entirely correcting the difficulty, two steam separators were introduced, and ultimately a superheater was built. After more experience, however, and some changes in the form of the burners, this superheater was found unnecessary for normal conditions.

Having arrived at the point where the oil could be burned successfully, it then became necessary to learn how to heat forgings, satisfactorily; the number of burners required to be used, the positions of these burners, and the time necessary to heat a particular forging sufficiently but not excessively, had to be determined- Among the condemned forgings at the arsenal was part of a 10-inch jacket and this forging was used for the various trials. Being very short in comparison with the 16-inch jacket, or even in comparison with 12-inch jackets which it was proposed to heat in the furnace before taking up the 16-inch jacket, this condemned forging was heated at various positions in the furnace. Three spots were turned on it, one near the bottom, one at the middle, and one near the top, and these spots, accurately measured when cold, and again when the heated forging was taken from the furnace, served to determine the amount of expansion and consequently the degree of heat. This forging was heated seven times on as many different days, the time of heating varying from one hour and thirty-five minutes to five hours, and the number of burners used varying from two to five. Absolutely necessary experience was thus gained not only in the manipulation of the burners, but also in handling parts of the furnace, covers, etc., and in removing a heated forging from the furnace.

The experience derived was held to be sufficient, and a 12-inch jacket shrinkage was then undertaken. The forging was heated with great caution and was frequently removed from the furnace to be measured. This shrinkage having been successfully accomplished, another 12-inch jacket shrinkage was undertaken. Examination of the furnace then developed the fact that the steel muffle was buckling at the bottom where burners of the lower row were more constantly in use and where the muffle was consequently subjected to greater heat. It was necessary, therefore, to remove the muffle from the furnace, have it straightened and stiffened in the lower section by tees, which would support the weight, and to add protecting plates where the flame from burners of the lower row impinged against it. As some annoyance had been experienced from deposit of soot on forgings being heated, advantage was taken of this opportunity to calk all the joints of the muffle. This modification required over a month to complete, but having been accomplished, two other 12-inch jacket shrinkages were undertaken.

It may be remarked here that in addition to the four 12-inch jackets already mentioned, which were heated in this furnace before the 16-inch jacket was heated, four other 12-inch jackets and four 10-inch jackets have since been heated and successfully shrunk on tubes, that experience in manipulating the furnace has reduced the time of heating from two days to between five and six hours; and whilst the first jacket heated was examined nine times to determine that it was properly and evenly heated, it is now necessary to examine a forging but twice. After the successful heating of the four 12-inch jackets above referred to, the final preparations for heating and shrinking the 16 inch jacket were taken in hand.

To drill the workmen in handling this piece, weighing about 74,000 pounds, and especially to drill the crane men in the operation of lowering the jacket into place on the tube, which operation had to be directed from a position 70 feet below the crane cage; a wooden tube, $\frac{1}{10}$ inch less in diameter than the bore of the jacket when cold, was constructed and placed in position in the shrinkage pit, and for a week two drills per day were held of the entire shrinkage operation. Finally, on March 28, 1900, at 2.30 p. m., the jacket being in the furnace, the burners were started to heat it for shrinkage. The expansions were tried at eight different spots a number of times. During the following day it was allowed to soak in the furnace with intermittent heating during the following night, and on the morning of March 30 its seating on the tube was attempted. The attempt was unsuccessful on account of warp and the jacket rubbed against the tube when within about 6 inches of its proper position. The crane was immediately reversed, the jacket removed without difficulty and returned to the furnace to cool. After three days, when cold, it was very carefully examined, to see that it had straightened while cooling, and the slight burrs which had been set up by rubbing against the tube were removed. The tube was also carefully examined too see that it had not been moved from its vertical position from this rubbing, and a week after the first attempt, on April 6, 1900, at 4.30 p. m., the furnace burners were again lighted to heat the jacket. During this heating the jacket was measured to determine its expansion three times, and on April 7 was successfully shrunk in place. This operation took the entire day. An examination, commencing at 7.30 a. m., was completed and the jacket returned to the furnace by 8.30 for additional heating at the breech end. It was again removed at 10.30, being out of the furnace at 10.41; measured and in position over the tube at 11.05; centered and started to lower over the tube at 11.16, and in place at 11.23. Preparations had been so made that water was applied to the muzzle end in less than one-half minute after the jacket was in place, and the application of water continued until 8.15 p. m., four water rings being used until about 4 p. m., the number of rings being then reduced to three, and during the last two hours of the cooling, to two water rings. So much water was used during the cooling that by about 4 p. m. the lower part of the shrinkage pit was filled with water to a depth of from 25 to 27 feet, notwithstanding the fact that the pit was practically free from water when the operation was commenced and the steam pump was running constantly. This pump continued to run even when submerged by as much as 6 feet of water, and soon after the number of water rings was reduced to three, the capacity of the pump caused the water to fall rapidly.

Besides the manufacture of a dummy tube to permit drills in the shrinkage operation, many other special precautions were taken and special preparations made to insure the success of the operation. In addition to the preparation of the bars, links, straps, hooks, etc., needed to handle the different parts of this gun, the preparation of carefully machined seats for straps for handling the heated forgings, the machining of a large bar, with eye ends, to be inserted in the tube to facilitate its handling, and the preparation of water cennections for interior cooking and for cooling the forging when seated, stages had to be built to permit examination and measurement of the heated jacket, and a special light caliper arm was made to be used in making the measurements. The set of this caliper arm was checked after each one of the eight measurements necessary to make a complete examination of the jacket.

Trussed straightedges with steel-shod feet were also manufactured, to be applied to the spots on the jacket to determine whether it was straight when heated. One of these, to be applied to the muzzle end and reaching up to the shoulder against which the D hoop abuts, was about 8 feet long, and the other, to be applied to the cylindrical surface above the shoulder, was about 18 feet long. These straightedges were applied each time the jacket was removed from the furnace, but the heat radiating from such a large forging made it extremely difficult for the men handling them to keep them steadily in place long enough to permit a very accurate observation to be made. Besides this, it was found that after each application the straightedge was more or less warped. The observations with these straightedges would only have disclosed a considerable warp in the heated jacket. Warp of a few hundredths of an inch could not have been determined.

In this connection it seems to be proper to remark here that in considering what must be done in the way of providing for the success of a shrinkage operation, it must always be remembered that a hot forging is to be reckoned with, and many of the things which seem advisable, and which could be done if the forging were cold, are consequently not feasible. There is a limit to the time men can stand near to a large heated forging, and in the case of one so large as this 16-inch jacket, this time is very short.

Star gauging and measurement of the jacket after the gun had been removed from the shrinkage pit showed that the compressions in the tube varied less than 0.002 of an inch from those allowed, and that the length of jacket was but 0.004 of an inch greater than its length before being shrunk in place. On being placed in the lathe and examined, it was found that no warp of the structure due to this shrinkage had taken place.

So soon as necessary measurements and examinations had been made the shrinkage surface for the D hoop was immediately turned. This turning consumed twenty-three working days, and the gun was again moved to the shrinkage pit for the D hoop shrinkage. Drills were again had in preparation for the shrinkage, which however present no point of special interest. The hoop was shrunk in place on May 10, 1900. The necessary star gauging and other measurements were made so soon as the gun was removed from the shrinkage pit, and it was then placed in lathe to have the shrinkage surface for A hoops turned. This turning consumed twenty-nine working days.

The weight of the gun at this stage was so great, nearly 200,000 pounds, that it was not considered safe to carry it along the craneway until after the latter had been strengthened and received the new rails for the wheels of the crane.*

The shrinkage of the A hoops has consequently been made with the gun in a horizontal position in the lathe where the shrinkage surface was turned, the heated hoops being carried by the crane to the gun instead of bringing the gun to the shrinkage pit. It may also be necessary later to make the shrinkage of the B hoops in the same manner.

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* CRANE WAY IN SOUTH WING OF GUN SHOP.—The top rail, instead of being rolled in one piece as required by drawings and specifications of April 1, 1891, was made in two pieces, consisting of a plate $\frac{3}{4}$ inch thick, with a top piece 4 inches wide by $1\frac{1}{4}$ inches thick, secured by countersunk bolts to the top plate of the main girders.

The top part of this rail, being a separate piece, has not sufficient sectional area to resist the stretching or peening action of the heavy, movable weights passing over it, which consequently cause shearing and breaking off of the heads of the countersunk bolts, and a flow of the metal, both in a longitudinal and transverse direction, necessitating constant repair and replacement of bolts every time one of the cranes passes over these rails with a 12-inch gun.

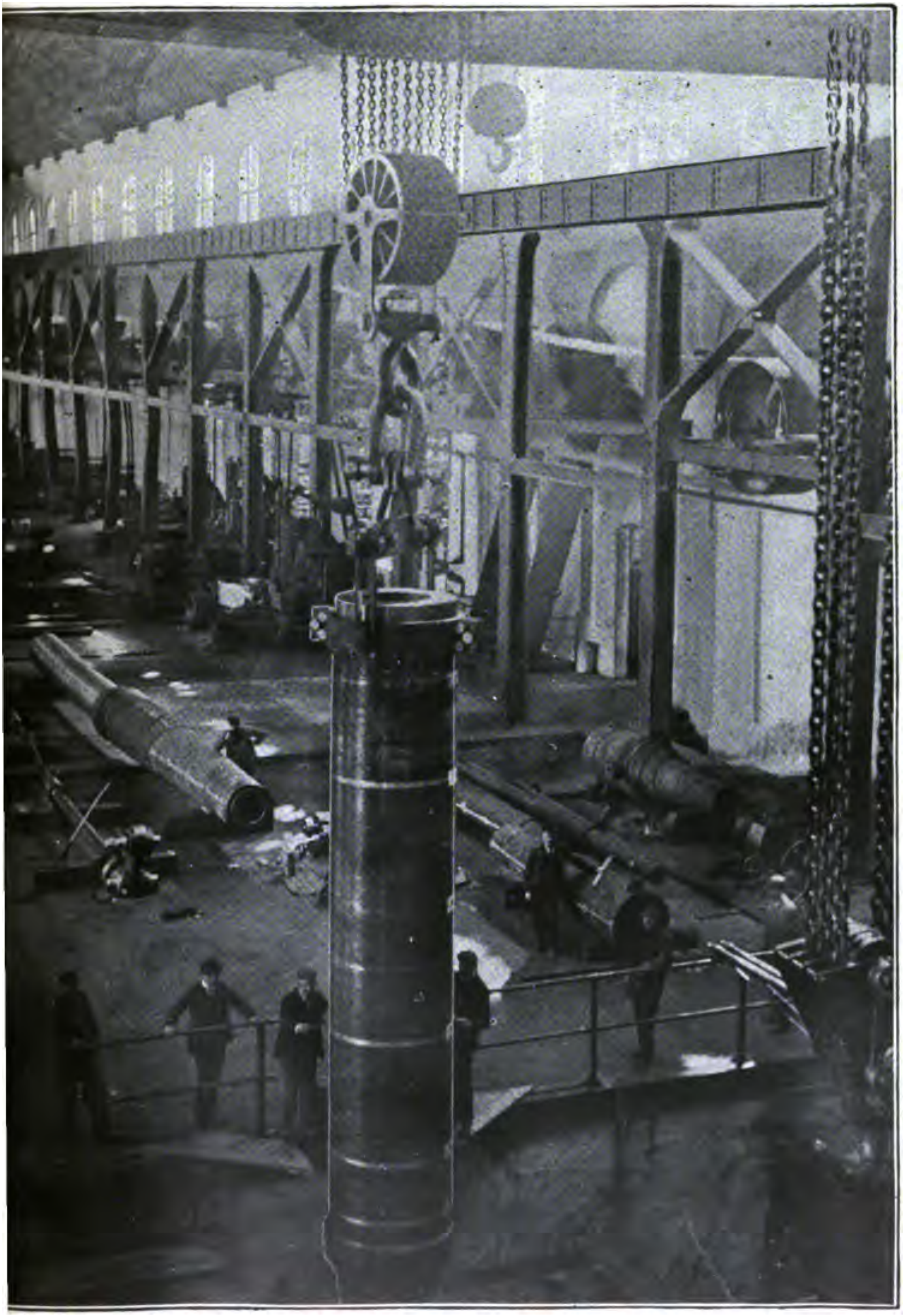
This stretching or peening of the top rail is further aggravated on account of the ends of each section of rail being flush with the ends of the girders, instead of breaking joints with the same.

One machinist and helper have had to work every day since this crane way was turned over for use, repairing the top rails and replacing broken bolts.

Another objectionable feature was the lack of sufficient bracing of the main structure of the post and girders, there being considerable longitudinal swaying when the crane was started or stopped with a 12-inch gun; this swaying would be further aggravated, and might become very serious, when heavier weights would have to be handled.

To overcome this latter difficulty a system of horizontal and diagonal bracing was introduced, the horizontal bracing being continuous, and the diagonal bracing alternating in the different bays throughout the length of the south wing. This bracing seems to have almost entirely eliminated the longitudinal swaying of the structure, and is shown in drawing dated Watervliet Arsenal, May 9, 1899. The work was performed by the Hilton Bridge Construction Company, of Albany, N. Y.

The more serious problem presented itself, however, in permanently repairing and strengthening the crane rails. The rolled solid rail, as originally called for, could not be obtained from the steel works without making new rolls, the old ones having been destroyed.



OTO PLATE A.—16-inch B. L. Rifle, Type. Measuring Exterior Diameter of Jacket to Ascertain Temperature.

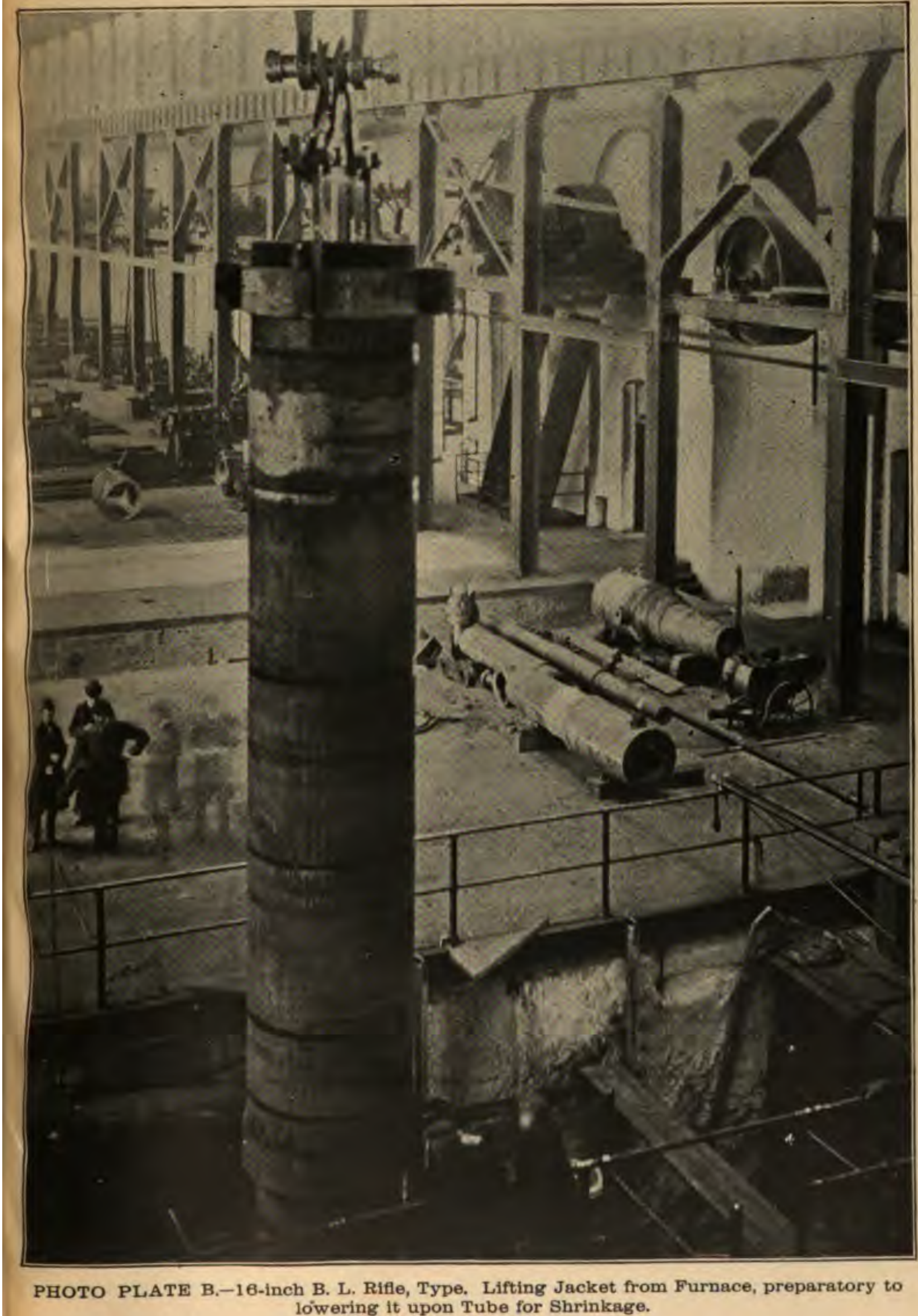


PHOTO PLATE B.—16-inch B. L. Rifle, Type. Lifting Jacket from Furnace, preparatory to lowering it upon Tube for Shrinkage.

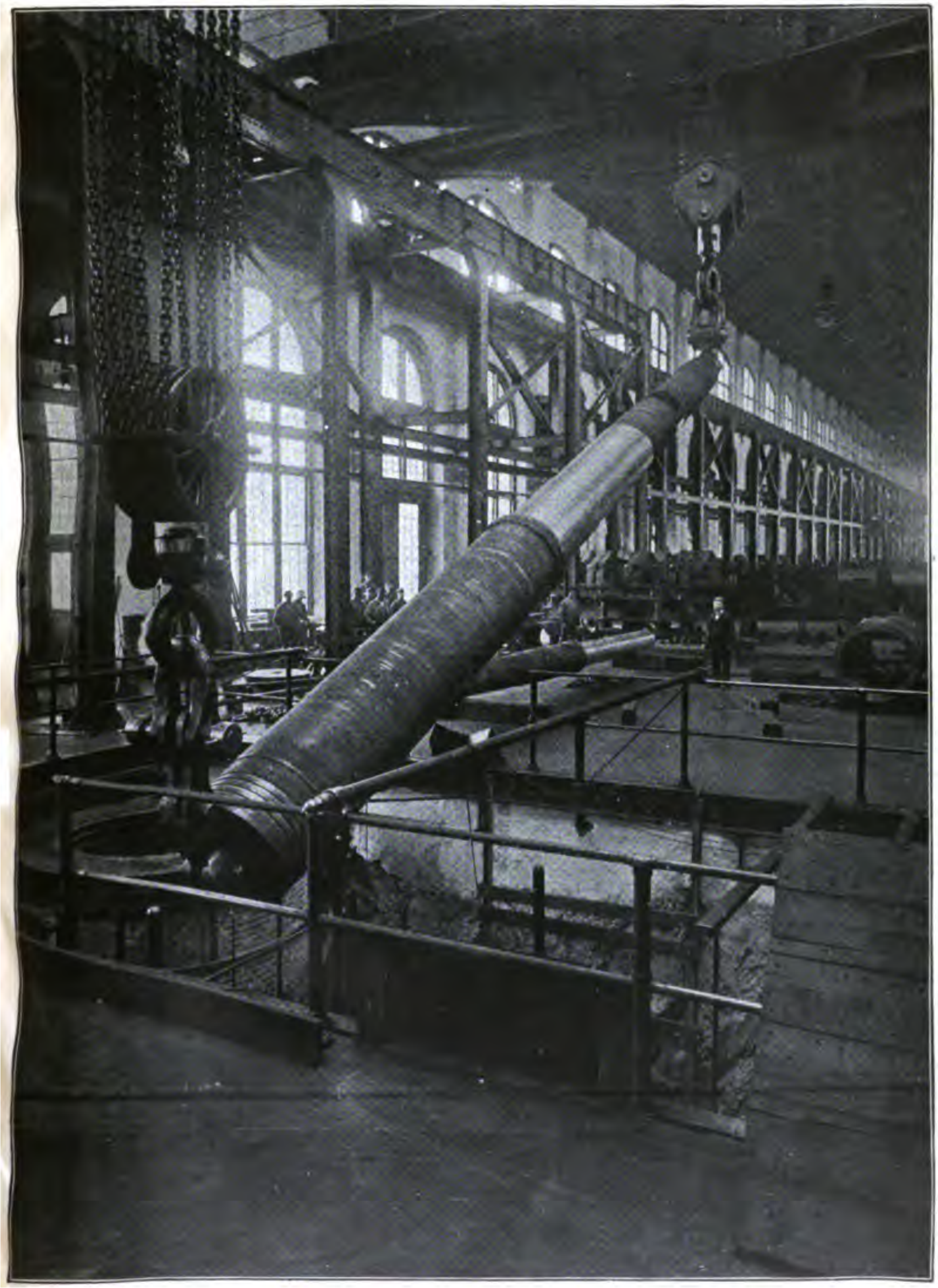


PHOTO PLATE C.—16-inch B. L. Rifle, Type. Lowering Gun into Shrinkage Pit to receive "D" Hoop.

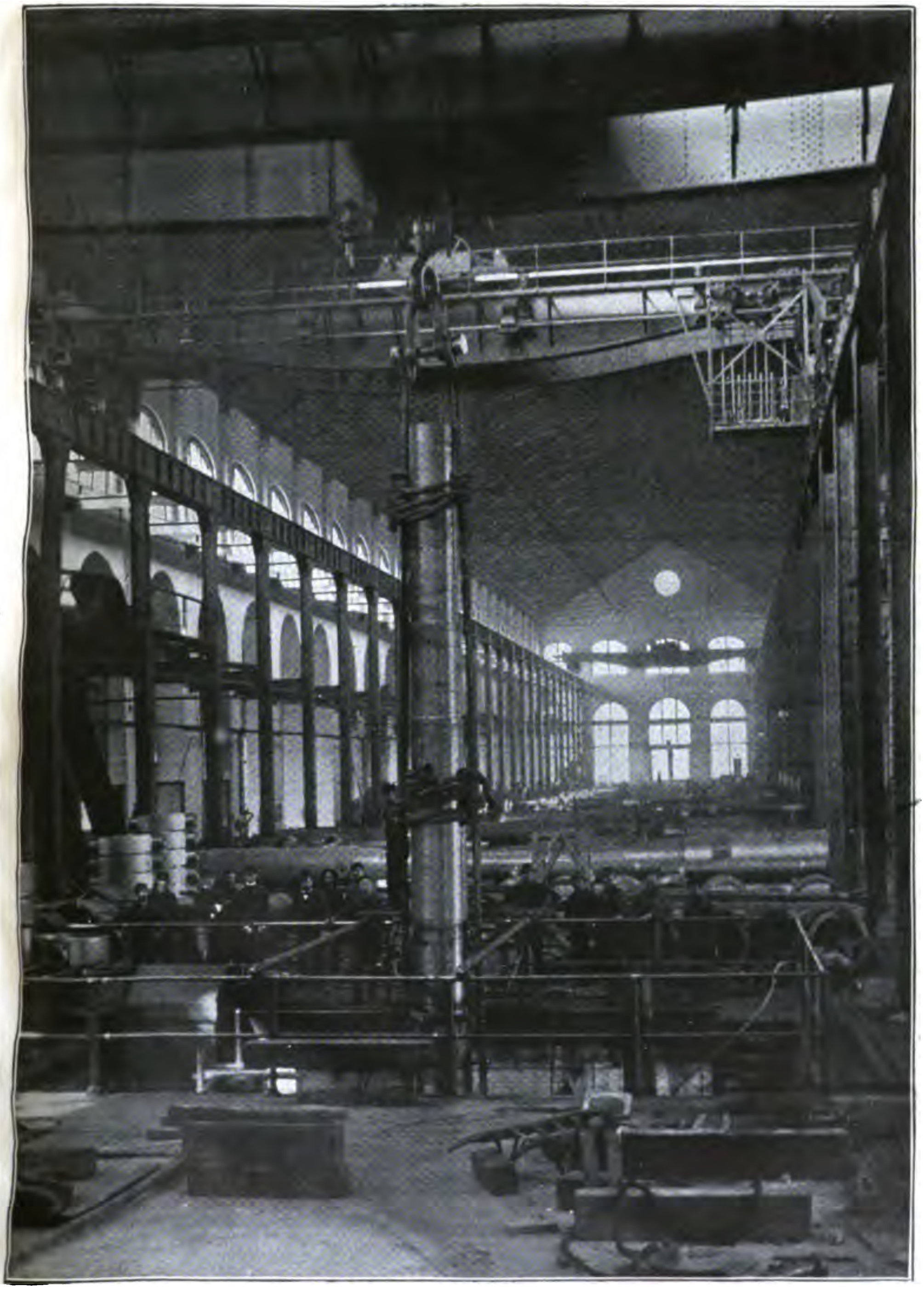


PHOTO PLATE D.—16-inch B. L. Rifle, Type. Lowering Tube into Pit preparatory to the Shrinkage of "C" Hoops.

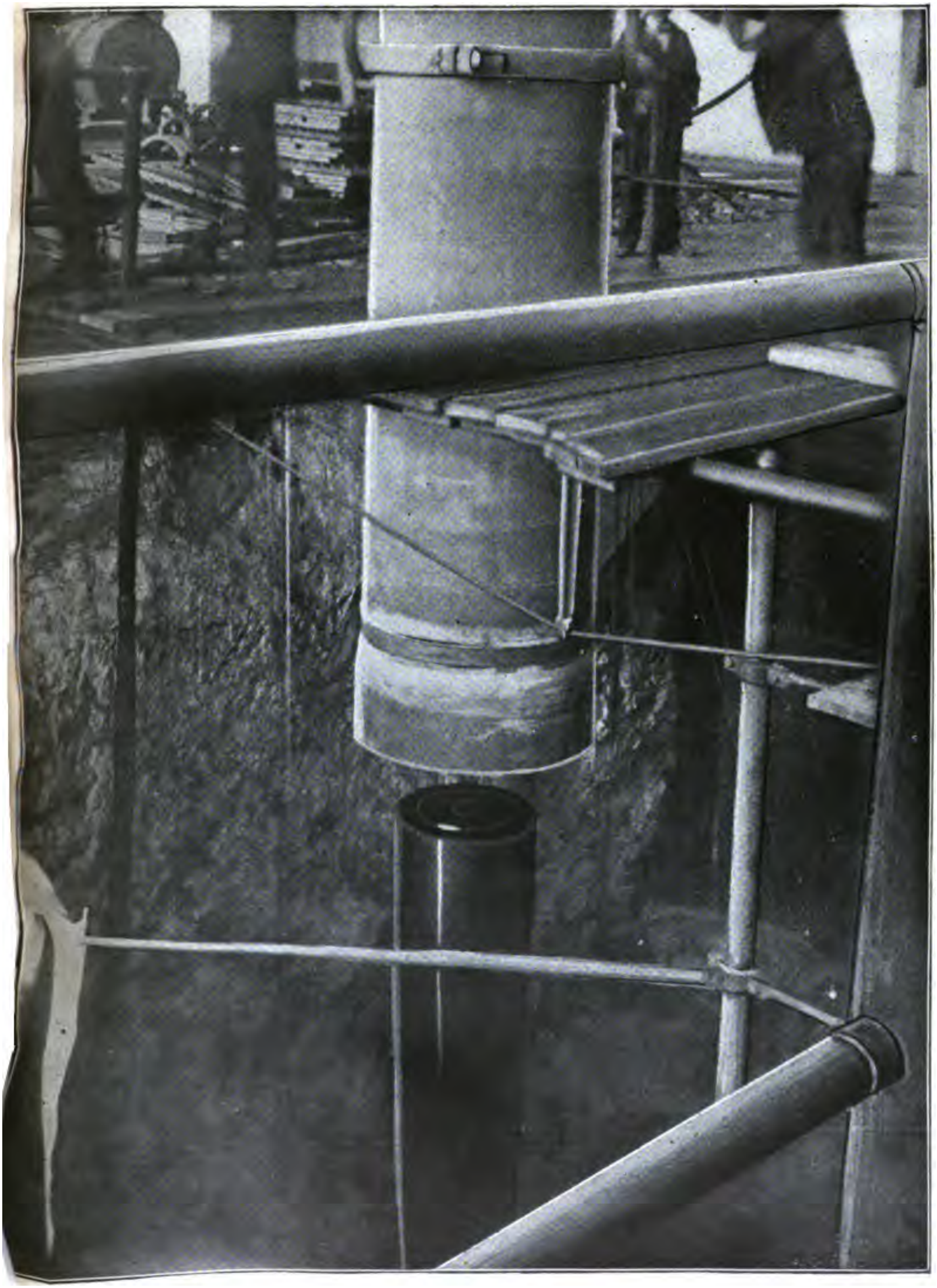


PHOTO PLATE E.—16-inch B. L. Rifle, Type. Assembling C^1 Hoop.

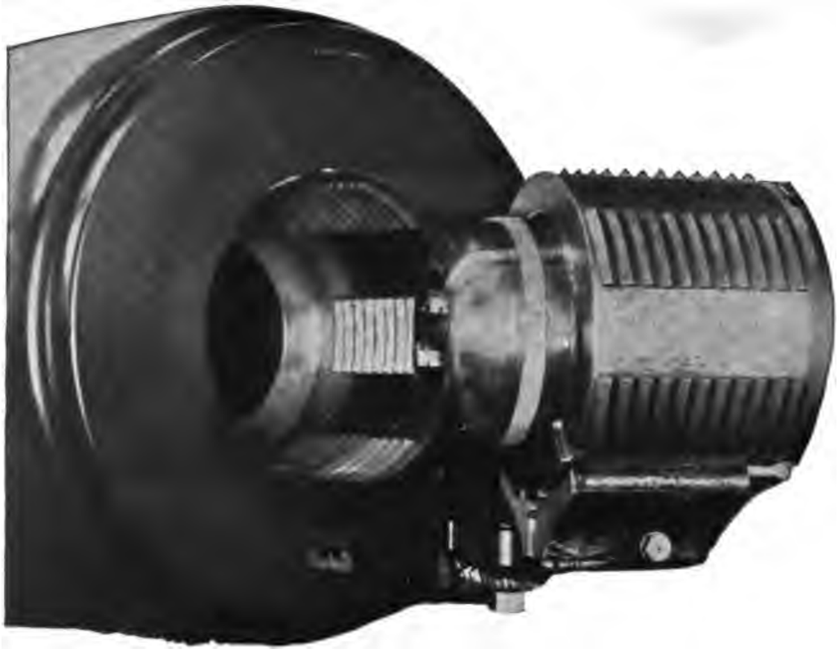
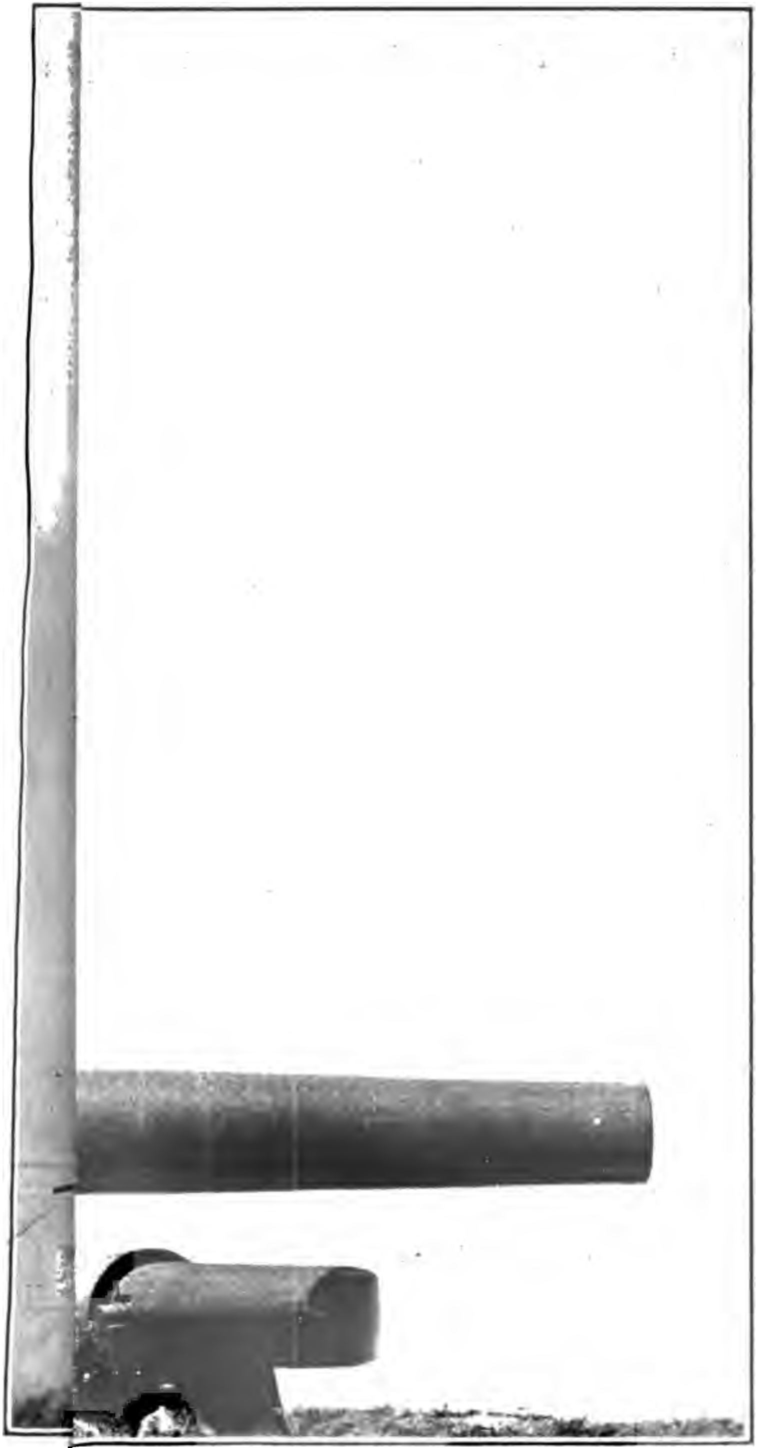


PHOTO PLATE F.—16-inch B. L. Rifle, Type. Breech Mechanism.

PHOTO



**der 10-inch Parrott Rifle, weight 26,000 pounds;
Projectile, 300 pounds.**

The shrinkage of the A hoops has been conducted as follows: The hoops were heated in the oil-burning furnace, were lifted from the furnace and tipped to the horizontal position on asbetos cloth-covered blocking by a crane, and the hoists of another crane were then attached to the straps on the hoop. The hoops were then carried to the gun, seated in proper position and cooled by water from the forward end, being held in place by the constant pressure of two 30-ton hydraulic jacks, one on each side, in the horizontal plane through the axis of the gun, the jacks being supported by wooden stands with the foot bearing against a clamped back rest.

It was found necessary to support the hoops at two points to permit accurate horizontal adjustment. An attempt was made to shrink the A 1 hoop, and it was at first proposed to shrink the others also, with the hoop supported at one point just over the center of gravity, but it was found this permitted too much swaying of the heated hoop and there was danger of the hoop getting crossed and sticking.

The position of the A 1 hoop being forward of the center of gravity of the gun in its present condition, the seating of this hoop required a change in the blocking supporting the breech end of the gun, during the operation of seating; the hoop, when about halfway to its proper position, being released by the crane handling it and being permitted to rest on the gun while another crane made the lift necessary for the change of blocking. So

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After corresponding with all the different steel manufacturers, it was found that rolled rails could not be obtained except at excessive cost and after long delay, and it was decided to order steel castings, which when sound and having the necessary physical qualities would fully answer the purpose.

The rolled rails as used in the craneway of the north wing would be too narrow for the south wing, as the girders of the latter are wider than those of the former, they being only 12 inches wide at the base, which would bring it inside of the vertical members of the main girders, causing abnormal strains on the bolts and rivets, due to the deflection of the top plates. A rail of greater width (16 inches) at the base, was therefore designed; this rail will distribute the great weights to be handled over the largest possible area, aud transmit part of the load directly over the vertical members of the girders. These rails will be located and fastened so as to overlap the joints between the girders.

These new cast-steel rails are required to show a tensile strength of at least 75,000 pounds per square inch; they must be sound and free from all imperfections and must be very nearly straight and true when received, although a slight warp or bend with concavity in the bottom of the rail may be permitted but no convexity in the bottom of the rail is allowed.

Eighty-eight of these steel castings will be 9 feet long, and twenty-four 9 feet 4 inches long when finished; about fifty have been delivered to date. They are made by Isaac G. Johnson & Co., of New York.

As the 15-inch guu in its assembled condition can not be safely carried over the existing crane rails, preparations are now being made to immediately replace the old by the new rail on such sections of the structure over which the gun will have to pass from one machine to another for the different operations; this work, embracing eight full bays or sixteen sections, is expected to be completed by September 1, 1900.

soon as this change had been made the second crane was immediately gotton out of the way, the first one resumed its former position, was attached to the hoop, adjustment of the hoists was again made and the hoop traveled to its proper seat. All this manipulation, with the attachment of water rings and water shedders, and the attachment and detachment of slings and hooks, consumed considerable time, so that it was twenty-nine minutes from the time the cover was removed from the furnace until the hoop was seated and water connections made, but previous experience had shown that the loss in expansion for this period was only about 0.03 of an inch, so there was no risk on this account. The seating of hoops A 2 and A 3 was a less difficult operation, since it was not necessary to shift the blocking.

The seating of the B 1, B 2, and B 3 hoops will be accomplished in the same manner as the seating of the A hoops, and since these hoops are of greater internal diameter than all others, the tolerance in expansion will be a maximum.*

After the final boring and rifling the gun will weigh 126 tons (252,000), and will be shipped to Sandy Hook Proving Ground for service test.

The estimated charge for this gun is 576 pounds of smokeless powder, and the weight of the armor-piercing shot is 2,400 pounds, the total cost of which is about $1,000 per round.

A recapitulation of the weights which have been handled:

	Pounds.
Tube alone	66,000
Tube with C hoops assembled	100,250
Jacket alone	74,000
Tube, jacket, and C hoops assembled	174,000
D hoop alone	23,000
Tube, with jacket and C and D hoops assembled	197,000

Referring to Capt. F. E. Hobb's report, which is an appendix to my report of principal operations at the Gun Factory for the year, I may here reiterate the statement that his report, from which I have herein freely quoted, is complete in detail, and that this officer, assisted by Master Mechanic A. Christiansen, M. E., has rendered most valuable service in connection with the construction of the 16-inch gun during the past year. Mr. Christiansen has had constant and immediate supervision of the installation of the plant for the manufacture of the gun—designed the shrinkage furnace, prepared all estimates, and has been directly responsible for the conduct of all operations.

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* The expansion per inch of diameter for each degree of temperature is 0.000007 inch. For an exterior diameter of hoop of 64 inches, we have for 1° of temparature 0.000448 inch, and for 800° 0.358 + inch expansion. Moasured exterior diameters at several points on the surface of a hoop, if uniformly increased by expansion, indicate uniform temperature and the amount of expansion the degree of temperature.

Expansion of hoop or jacket in general, may therefore be expressed as $0.000007\,(a-s)$, in which a = diameter of the cold tube and s, the *shrinkage*.

The *shrinkage* is the diameter of the tube (cold) less the diameter of the hoop or jacket (cold).

The *diameter of the jacket*, is equal to the expansion $+ (a-s)$.

The *clearance* = expansion $+ (a-s)-a$.

(To be continued.)

THE DEVELOPMENT OF THE KRUPP FIELD ARTILLERY MATERIAL.*

(Translated from the German by M. WILLIAMS, and arranged for publication in the office of the Chief of Ordnance.)

(Continued.)

IV.

PACKING OF AMMUNITION.

The packing of the ammunition is of the greatest importance for the piece as a rapid-fire gun. If the ammunition is put loosely into the limber, the latter can carry more projectiles than when ammunition boxes are used. The weight of the ammunition transported, in proportion to the loaded and empty limber, is more favorable. This method of packing offers weighty objections. Bringing up the ammunition by hand to the gun either diminishes the rapidity of fire, or the number of carriers exposed to fire must be increased. The lack of the ammunition boxes will be especially felt if the detachment has suffered losses, or if, in the case of prepared positions of defense, the ammunition must be under cover in or near the battery. Ammunition boxes are meant to protect the projectiles from the influences of the weather and from being covered with dirt. In order to withstand the shocks they are exposed to during transportation they must be very strong. Krupp's factory has, therefore, abandoned the use of aluminum in their construction. A means to mitigate the drawbacks of packing without ammunition boxes has been tried by carrying two or three ammunition boxes or portable leather ammunition sacks which can be filled with projectiles and carried to each gun. The packing and unpacking of the ammunition, however, requires both strength and time; consequently this system can not be considered practical. It is furthermore necessary in any case to lay some projectiles down by the gun, in order to avoid an interruption of the fire in case of the loss of an ammunition carrier, or when increased rapidity of fire is desired. The above-mentioned remedy, for this reason, is not of much value.

In the Krupp limbers the ammunition is packed in boxes, whether it be fixed ammunition or whether it be separate (projectile and metallic case). These boxes are made of various models. The

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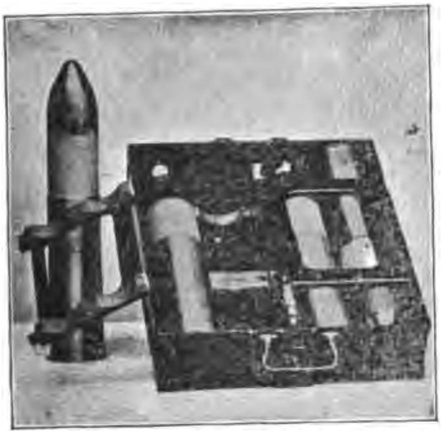
[*] Reprinted by permission of the Chief of Ordnance, U. S. Army, who also very kindly loaned us most of the plates.—ED.

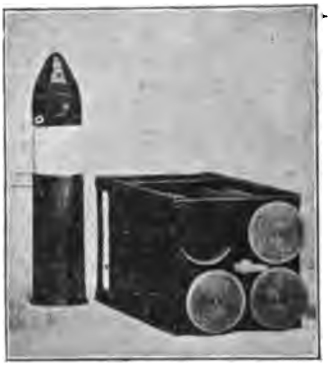
PLATE X.

Ammunition boxes for 2.95-inch rapid-fire field guns.

II. FOR FIXED AMMUNITION.

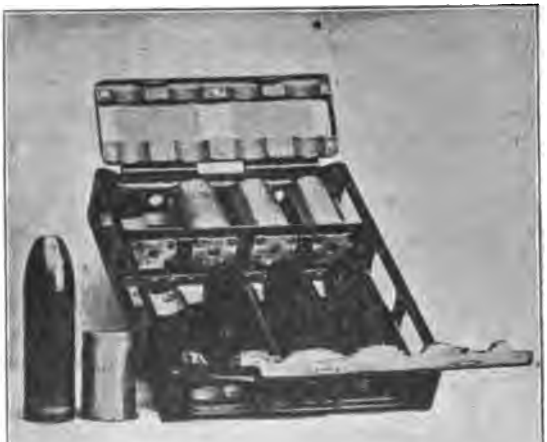


A.—For heavy cartridges.



B.—For light cartridges.

II. FOR DIVIDED AMMUNITION.



C.—For projectiles and metal cartridge cases.

usual one is shown in A, Plate X; another sort is marked B, on the same plate. When separate ammunition is used, it can be so packed that an equal number of projectiles and cases can be put together in an ammunition holder, or else projectile boxes can be provided for the projectiles and cartridge sacks for the cartridges. The first way (see Plate X, C) is the most practical, because in case of diminished service the firing can be kept up without interruption, while the regularity of the service is better assured by having the same number of cases and projectiles together.

The number of rounds packed in an ammunition box depends on the weight of the individual round, so that the full box can be handled by one man. Forty kg. (88 pounds) should be the limit of weight allowed, and 5 or 6 rounds for the light field gun or 4 or 5 rounds for a heavy field gun could be carried therein (see Table IV, concerning limber models). To facilitate the handling of 40 kg. (88 pounds) ammunition boxes, leather carrier straps are added.

For special cases, where a large number of rounds were required in comparison to the weight, and when the purchaser especially desired the omission of the ammunition boxes, the factory furnished limbers with loosely packed ammunition (see Plates XI and XII).

The projectiles are always packed in a horizontal position, partly because in this way the limber chest need not be so high, and the center of gravity of the limber is brought lower down, and also because the horizontal packing is better for the preservation of the ammunition and for the safe packing of the fuzes than the upright position of the projectiles. Transportation tests have shown that it is by no means an indifferent matter as to whether the projectiles are laid longitudinally or transversely. The result of tests has caused the Krupp factory to adopt the former direction, for, when laid transversely, the cartridges have a tendency to roll about, thereby scraping against each other, and endangering the safety of packing. The strain on the limber during transportation is remarkably heavy, and a light or weak construction, even if it proves efficient under short tests, wears out in time with hard usage, and requires changes and subsequent strengthening. It is therefore a mistake in this division of the weight of the system, between the gun and its carriage on the one hand and the limber on the other, to increase the weight of the former at the expense of the latter. In the construction of ammunition boxes, as well as of limber chests, the factory has given up the use of aluminum plates, as even in comparatively

TABLE IV.—LIMBER CONSTRUCTIONS BUILT FOR RAPID-FIRE FIELD GUNS.

	I	II	III		IV			V			VI		VII	VIII	IX	X		XI
No.	Piece.	Gauge.	Wheel.		Weight.			Number.			Weight of ammunition boxes.		Has the limber a wheel brake.	Is limber on springs or rigid?	Are two limbers used for caisson?	Ratio of weight of ammunition carried to weight of limber.		Remarks.
			Diameter.	Weight.	Limber without ammunition and without implements.	Limber with ammunition and implements.	Ammunition carried.	Rounds.	Ammunition boxes.	Rounds in each ammunition box.	Empty.	Filled.				Empty.	Filled.	
	FOR SEPARATE AMMUNITION.	*Inches.*	*Inches.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*				*Pounds.*	*Pounds.*				*Per cent*	*Per cent*	
1	2.95-inch, L. 27	60.237	53.937	174.10	1,215	1,784.0	463.0	[1] 42	[2] 8	5	19.4	76.7	No...	Rigid.....	No...	39.7	27.2	The limbers are arranged according to date of construction. In No. 1 the metal cartridges are contained in cartridge sacks.
2	2.95-inch, L. 28	60.237	53.937	175.30	1,157	1,806.0	527.0	[3] 35	[4] 7	5	17.4	82.0	No...	... do	No...	45.5	29.3	
3	2.95-inch, L. 28	60.237	53.937	156.50	1,190	1,843.0	560.0	[5] 34	[6] 8	4	23.6	89.3	No...	... do	No...	47.2	30.5	
4	Mean, 1-3..	60.237	53.937	168.70	1,186	1,810.0	522.5	37	....	....	20.1	82.7	....	....	....	44.1	29.0	
	FOR FIXED AMMUNITION.																	
5	2.75-inch, L. 22	58.270	47.240	115.80	992	1,699.0	633.0	[1] 50	8	6	16.5	92.4	No...	Rigid.....	No...	64.0	37.2	
6	2.75-inch, L. 26	49.210	49.210	110.23	944	1 550.0	547.0	40	10	4	7.5	62.2	Yes..	Springs	Yes..	58.0	35.3	
7	2.90-inch, L. 24	49.210	51.580	111.35	8,6	1,559.0	576.0	[1] 50	8	6	15.9	84.9	No...	Rigid.....	No...	64.2	37.0	
8	2.90-inch, L. 24	49.210	50.790	112.45	924	1,535.0	551.0	40	10	4	7.1	62.2	Yes..	Springs	Yes.	59.7	35.8	
9	2.90-inch, L. 28	58.270	52.360	136.70	1,047	1,702.0	564.0	[1] 34	8	4	17.6	84.0	No...	Rigid.....	No...	53.9	33.0	
10	2.90-inch, L. 28	58.270	52.360	136.70	1,034	1,702.0	576.0	[1] 34	8	4	17.6	85.1	No...	... do	No ..	55.8	33.7	
11	2.90-inch, L. 28	58.270	53.150	157.70	1,076	1,782.0	613.0	[1] 34	8	4	17.6	89.7	No...	.. do	No ..	57.0	34.5	
12	2.90-inch, L. 28	53.740	52.360	136.70	986	1,691.0	613.0	[1] 34	8	4	17.6	89.7	No .	... do	No...	62.0	36.3	
13	2.90-inch, L. 30	47.240	52.360	136.70	911	1,585.0	587.0	[1] 34	8	4	16.5	85.3	No..	... do	No...	64.6	37.2	
14	Mean, 5-13..	53.540	51.260	128.50	968	1,647.0	584.0	....	....	....	14.9	....	....	....	....	59.9	35.6	
15	Mean, 5, 9, 10, 11.	58.270	51.260	136.70	1,036	1,724.0	596.0	....	....	....	17.4	....	....	....	No...	57.7	34.6	Broad gauge; chests without springs.
16	Mean, 6, 7, 8, 13.	48.740	51.000	117.75	917	1,557.0	565.0	....	....	....	11.7	....	....	....	....	61.6	36.3	Narrow gauge; chests without springs.
17	Mean, 6, 8..	49.210	49.000	111.35	933	1,543.5	549.0	....	....	....	7.3	....	....	....	Yes..	58.9	35.6	Narrow gauge; chests with springs and wheel brake.

---

[1] Including two rounds of canister on the limber frame.

[2] Ammuuition boxes arranged for five projectiles and five metal cartridges.

[3] Plus three metallic cases, two for cartridges on carriages and one for reserve

[4] Boxes for five projectiles.

[5] Including two rounds in cover on the limber frame.

[6] Ammunition boxes arranged for four projectiles and four metallic cartridges.

large dimensions the power of resistance of thin steel plates is not attained, and, furthermore, aluminum plates suffer badly from exposure to the weather.

Table IV on previous page gives a résumé of the newer limber constructions. The carrying capacity of the limber, as shown in column X, does not come up to the claims often made in literature, where it is sometimes demanded that the ammunition load shall amount to 50 per cent of the whole weight. Such high utilization is attainable, but only at the sacrifice of the strength of the whole system, or of the convenience, capacity during action, and security of the structure, either by leaving off the ammunition boxes and tools, or by doing away with the limber chest and seats. If one adheres to the tested strength and arrangements, the attained capacity of 35 to 36 per cent is quite considerable, and this is only made possible by the most careful saving of weight.

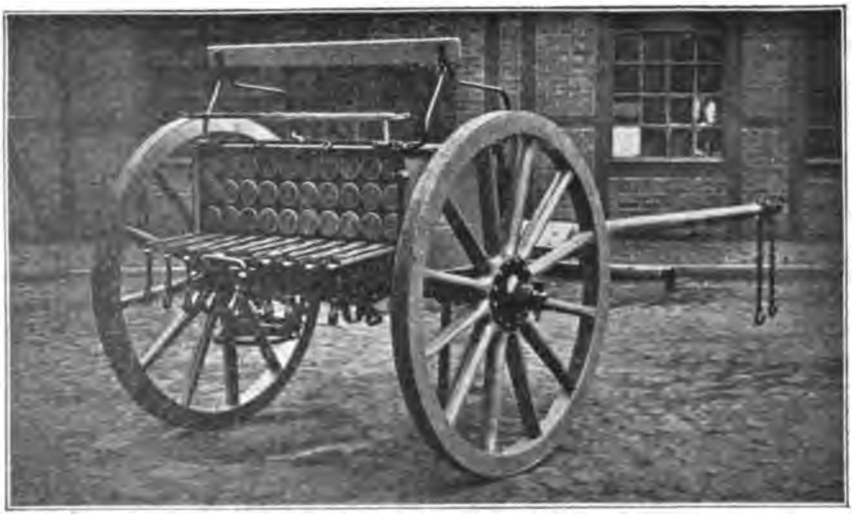
By the use of a dynamometer with a limbered gun, Krupp's factory undertook experiments to determine practically the theoretically easily calculated horsepower necessary for transportation (movement).

AMMUNITION AND BALLISTIC CONDITIONS.

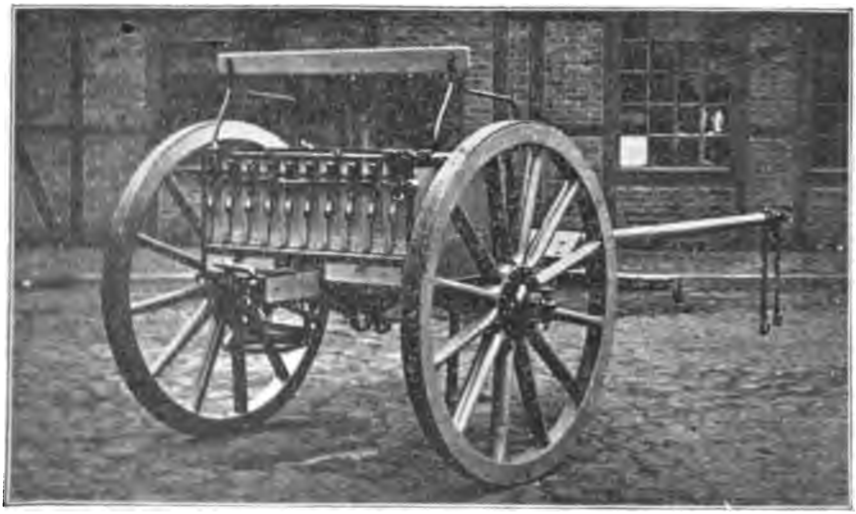
After the introduction of smokeless powder and rapid-fire guns it became desirable to inclose the gun charge in an obturating metallic case, containing also the primer. It remained still to be decided whether the projectile with the metallic case should be combined in a single cartridge or whether it should be handled separately from the case. As long as there has been but little experience with metallic cases and smokeless powder the combination cartridges turned out to be heavy and long, consequently Krupp's factory was inclined to give the preference to projectiles separate from the metallic cases. For instance, the weight of the case of a projectile weighing 3 kg. (6.6 pounds) and having a muzzle velocity of 420 m. (1,375 feet per second) for a 6-cm. (2.36-inch) rapid-fire gun, L. 30, was 1.05 kg. (2.31 pounds), the complete charge weighing 4.25 kg. (9.35 pounds), and nearly 0.5 m. (19.7 inches) in length. The weight of the case, therefore, amounted to 35 per cent of that of the projectile, and 25 per cent of that of the round. In the same degree that it became possible to control the relations of charge, burning space, and energy of motion of the projectile, and to improve the manufacture of cases, these became correspondingly shorter, lighter, and more suitable for the purpose, and the advantage which metal cases for powder charges alone previously possessed over fixed

PLATE XI.

Field limber for thirty 3.-inch-cartridges, without ammunition boxes.



A.—Limber entirely open.



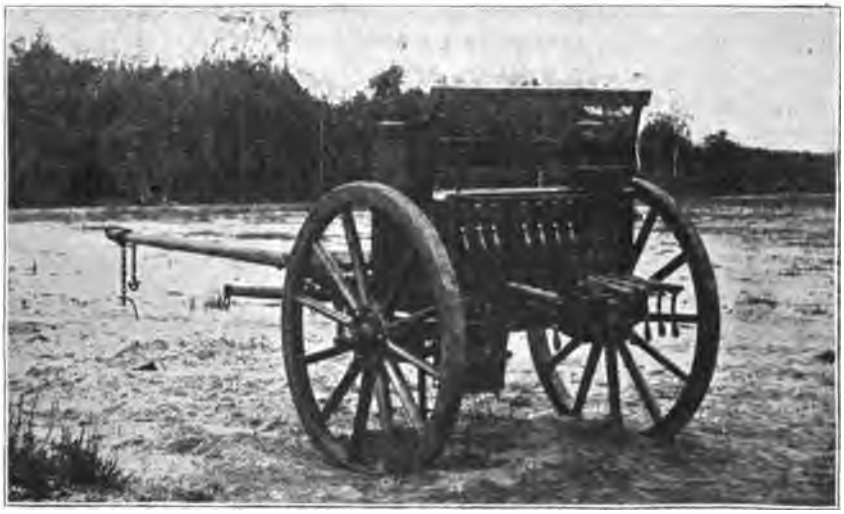
B.—Limber closed.

ammunition was diminished. In later designs the weight of the above-mentioned 6-cm. (2.36-inch) cartridge case, with the same projectile effectiveness, was only 0.46 kg. (1.01 pounds), that of the round only 3.66 kg. (8.05 pounds). The weight of the case, therefore, was only 15.3 per cent of that of the projectile and 12·5 per cent of that of the round. The former weight of the 6 cm. cartridge case of 1.05 kg. (3.21 pounds) is now about that of a 7.5-cm. (2.95-inch) cartridge case, for a 6.5-kg. (14.3-pound) projectile and a muzzle velocity of 500 m. (1,648 feet per second). The metal powder case for this last weighs, with its cover, 0.62 kg. (1.36 pounds). The comparison of both kinds of ammunition—that is, methods of loading, combined or separate—leads to the following result:

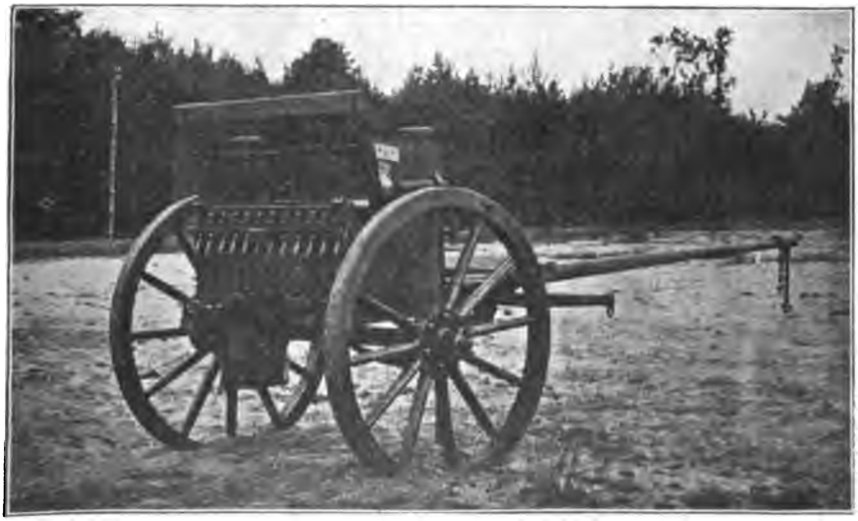
The handling and placing of the fixed ammunition is simpler than that of the separate projectile and cartridge case. It requires only one handling, whereas the cartridge and projectile need two, a circumstance which in many cases may unfavorably influence the rapidity of fire. The storing of ammunition cartridges in the wagons is more simple than that of separate ammunition, as the latter requires different arrangements for projectiles and cartridges, as already explained in the limber chapter, which makes the construction more complicated and increases the weight so much that the lesser weight of metal powder cases as against those of fixed ammunition is again equalized. With fixed ammunition the loading rammer is an indispensable appliance. The supply of ammunition during firing is simpler and more regular when the projectile and the cartridge are combined. The safe keeping of the ammunition in the limber can be attained as well in the case of separate as of combined ammunition. The fixed ammunition cases, thrown out after each round, always fall on the side, whereas the cartridge cases sometimes remain upright and are liable to wound the horses, owing to the sharp, upturned edge of the shell. The uniformity of the original burning space is more assured with combination cartridges than with separate projectiles, so that the extra accuracy of fire expected, owing to the uniform entrance of the projectile in the grooves by means of the rammer, is again equalized. The superiority of combination cartridges in this respect as against divided ammunition is especially noticeable during firing, in the battery, with guns which have been in use for some time and which are unequally worn. The combination cartridge permits of a better shape for the powder charge, in comparison to the available air space, also the arrangement of

PLATE XII.

Spring field limber for forty-eight 2.56-inch cartridges, without ammunition cases.



A.—Limber partially open.



B.—Limber closed.

an air cushion most favorable to the attainment of a low pressure. In order to restrict its size, the metal case is so dimensioned that it can just take the powder charge, so that the air cushion can only be between the charge and the base of the projectile. The combination cartridge has been criticised because, added to its increased weight, it requires greater storage space in the limber chest. To offset this, be it remarked that the increased weight of the limber chest, required by the length of the combination cartridges, is surpassed by the greater weight of the device for packing separate amminution (see Table IV). The difference in weight of the fixed ammunition case and the separate metallic case, with same effectiveness of fire, can be seen in Table V. With a caliber of 7.5 cm. (2.95 inches) a saving of 0.5 kg. (1.1 pounds) per round on 30 rounds in the limber would give a total saving of 15 kg. (33 pounds). Table IV shows that this decrease in weight is of no account as compared to the poor utilization of limber space in the case of separate ammunition.

It has been said of fixed ammunition that it necessitates throwing away the whole rounds, if the primer fails, unless it is carried along as dead weight, whereas with separate ammunition, provided always that extra cases are carried, the metal cartridge would only have to be exchanged for another. The use of Krupp's screw primers (Fig. 23*a*, 23*b* and 23*c*), in the base of the case obviates this trouble, because in either instance it is only necessary to replace one screw primer with another.

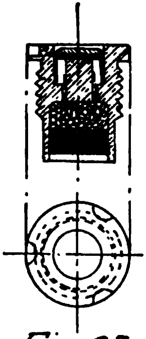


Fig. 23a

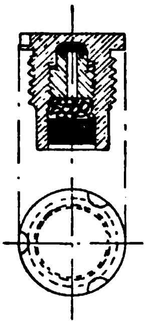


Fig. 23b.

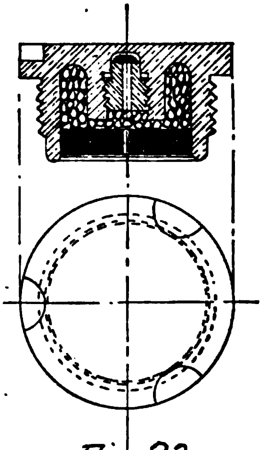


Fig. 23c.

To determine the influence of the ammunition and method of loading on the accuracy of fire, the factory has made various tests. Of these the following only are mentioned:

1. With a 6.5 cm. (2.56-inch) rapid-fire gun, L. 35;
2. With a heavy 7.5 cm. (2.95-inch) rapid-fire gun, L. 28.

The result can be summarized by stating that as regards accuracy of fire, no difference can be established between the use of fixed and separate ammunition. At the second trial the rapidity of fire was also observed, and it was shown that under otherwise equal conditions the result of separate ammunition was 10 per cent less than with fixed ammunition. To further reduce the weight of the cases, the factory made some with an aluminum alloy and fired them in competition with brass cases. The test was made with the 7.5-cm. (2.95-inch) cartridge case, marked No. 2 in Table V. The weight of the aluminum case, including the brass primer, amounts to 0.29 kg. (.64 pound) as against 0.89 kg. (1.96 pounds) of the brass case. The saving in weight is therefore considerable, viz, about two-thirds. For a limber carrying 30 cartridges for 7.5-cm. (2.95-inch) rapid-fire gun, L. 28–30 (in Table V, No. 4), the saving in weight would amount to 30 × 0.75 = 22.5 kg. (49.5 pounds).

TABLE V.—TABULATED DIMENSIONS AND WEIGHTS OF SOME BRASS CASES FOR RAPID-FIRE FIELD GUNS.

	I	II	III	IV	IIa	IIIa	IVa	V
		Cartridges cases for fixed ammunition.			Cartridge cases for separate loading.			
No.	Piece.	Outside length.	Weight, with screw primer.	Capacity.	Outside length, with cover.	Weight, with screw primer and cover.	Capacity, including cover.	Remarks.
		Inches.	*Pounds.*	*Cubic inches.*	*Inches.*	*Pounds.*	*Cubic inches.*	The weight given in columns III and III*a* include the screw primer shown in figure 23c.
1	2.56-inch, L. 31	8.15	1.45	29.28	4.21	.82	19.52	
2	2.76-inch, L. 26-28	8.07	1.96	34.77	4.13	1.10	23.18	
3	2.95-inch, L. 24	7.48	1.76	37.82	3.86	.97	25.00	
4	2.95-inch, L. 28-30	10.94	2.47	61.00	5.63	1.37	40.26	
5	2.99-inch, L. 29	15.75	3.18	98.82	8.07	1.76	61.61	
6	3.07-inch, L. 28	13.19	2.95	82.35	6.77	1.63	54.29	

Opposed to this advantage are the following drawbacks: The cost of the aluminum cases is higher; moreover, for practice fire they are still more expensive, as they do not stand firing as many times as the brass cases. In the firing tests with low gas pressure, 1,200 atm., the aluminum cases behaved well, but they only withstood four-fifths of the average number of rounds that the brass cases endured. Of course this is only of importance for practice fire, as in action the empty cases are thrown away. With higher gas pressure, such as occurs usually with field guns, not only did the cases become useless after a few rounds, owing to the burning away of the front edge, but they caused difficulties in loading.

It has been attempted in some quarters to retain the former cartridge bag, making it easier to handle by adding a combustible but stiff casing, and, if possible, combining it with the projectile into a single cartridge. For the casing celluloid has been principally used. The tests made by the Krupp factory show that the celluloid casing influences unfavorably the uniform combustion of the powder. Furthermore, a combination of case and projectile can not be attained, as celluloid in the dimensions which might be required would not have sufficient strength. All that could be done would be to use it for separate ammunition. Even in this instance, to preserve the advantages to be obtained from a new gas check for every round, also the combination of the primer with the case, in other words, rapid loading, it would be necessary to have at least a short metal case—that is, a case bottom with a short protruding rim. If this is done one can go a step further and prolong the addition to a case jacket, which develops then again into the metallic cartridge. The case bottom is the heaviest part of the whole case, whereas the jacket is comparatively light. The factory also made tests with a combination of the ordinary cartridge bag (without celluloid jacket) and a short metal cartridge case, in which the bag was fastened by a special device to the interior of the base (Imperial German Patent 67,534 of April 29, 1892), and the Chamber of the gun was so constructed as to obtain good obturation (Imperial German Patent 72,590 of February 5, 1893). In spite of above-mentioned points of view, the factory has always come back to the use of metallic cases for the powder or to that of fixed ammunition.

POWDER.

The smokeless powder used by the Krupp factory is obtained from the United Cologne & Rothweiler Powder Works. Powder free from nitrolycerin, made of pure nitro-cellulose, as well as powder containing nitroglycerin is used, the latter principally in tube form.

This form is better fitted to insure uniform combustion, and, owing to its lower gravimetric density, it becomes possible to fill with the charge the burning space entirely or almost so. An especial air cushion is no longer a necessity and an unalterable shape of the charge is obtained, which is important for the uniformity of gas pressure, rapidity, and accuracy of fire. Both kinds of smokeless powder mentioned have proved satisfactory under the most varied conditions and both possess the necessary stability for magazining.

This is not the place to treat more closely of the details, or to emphasize the advantages of one sort of powder over the other. Only it must be stated briefly that as far as effectiveness in relation to weight is concerned, the powder containing nitroglycerin proves more satisfactory than pure gun-cotton powder. Be it further mentioned that it has been possible to so far reduce the temperature of combustion of the powder containing nitroglycerin as to make it almost equal to that of the nitrocellulose powder, which is free from nitroglycerin.

PROJECTILES.

The principal projectile of the field artillery is shrapnel, and in most instances it is possible to use it exclusively.

In some countries where difficult conditions have to be met, with imperfectly trained troops, a small equipment with ring shell or canister, or both, besides shrapnel, may appear advisable, as these projectiles have the advantage of easier service and less cost. Canister cannot be entirely replaced by shrapnel, at least not for a short range, viz, up to 200 m. (610 yards), and as long as shrapnel is fired at zero cut. Canister is only given up for reasons of simplification of ammunition.

EXPLOSIVE SHELLS.

Before considering shrapnel as the main projectile, mention must be made of high explosive shell. The two forms in which they appear are thin-walled mining shell with heavy charge, and the thick-walled explosive shell with small charge. The mining shell has the greater effectiveness, especially when detonated in a closed space. These cases, however, occur rarely in the field and then generally, the effect of a shell filled with less explosive, or shrapnel fired with a time faze, would not only be sufficient, but would merit the preference because of the greater effects of its fragments. All considerations of safety are against the use of mining shell. If an explosive shell is carried at all, Krupp's factory is of the opinion that it can only be used advantageously in the manner of the former ordinary or ring shell. The thick-walled explosive shell has over both the advantage of greater effects of its fragments and greater explosive effect. It exceeds in the former quality even the mining shell. and it is also possible, owing to the comparatively light weight of the high explosive charge, which in the case of picric acid, or similar explosives, amounts to 2½ or 3 per cent of the weight of the projectile to make the gun safe against explosion. Krupp's factory uses smokeless powder in the place of picric acid, in little cubes with an addition of black powder, the latter serving as an igniting charge as well as its smoke being of use as a means of observation. Sensitive detonators thus become unnecessary. Tests have been carried on by Krupp's factory with explosive shell and smokeless powder, including a few instances with picric acid as a bursting charge. From these it was seen that the detonating power of smokeless powder, combined with gunpowder, is hardly inferior to that of picric acid. The use of a time fuze in explosive shell is not well adapted to its purpose. The effectiveness of an explosive shell, which, owing to its wide cone of dispersion, is meant to hit objects behind cover, can, for several reasons, only be slight when exploding in the air any great distance above the target; in order to obtain satisfactory results there must be assured recognition of the target, great accuracy of ranging, a good control of height of bursting point and continued careful observation. In the field it is seldom possible to meet all these requirements, as, furthermore, the fragments are scattered with superfluous energy in all directions, almost normally with the line of flight, not half the weight of the projectile is effective downward, while the remaining fragments fly ineffectively through the air. Finally, it is easy for the enemy behind cover to erect defenses, as thin 1-inch boards afford protection against obliquely falling shell splinters. Explosive shells, detonating in the air, have only one quality which may under certain circumstances be advantageous, that is, their wide spread of effectiveness.

The use of explosive shell with time fuzes and field (flat-trajectory) guns would appear to obviate the necessity of high-angle fire. Judging from the experience of Krupp's factory, this view is erroneous. If the high-angle fire is necessary the task of the explosive shell can also be assigned thereto, and for flat-trajectory guns this projectile can be discarded. In short, one must not expect a sort of projectile to do what only a special sort of gun can accomplish. The construction of rapid-fire howitzers for field service has been fostered for a long time by Krupp's factory. It is intended to discuss the new opinions on the subject, the models of construction executed during recent years, the results of tests and the collective experiments, in a subsequent publication.

(To be concluded.)

PROFESSIONAL NOTES.

ORGANIZATION.

Army of Peru.

In accordance with the law promulgated in June, 1899, every citizen is liable for compulsory military service from 19 to 50 years of age.

The Army is divided into five parts, viz.:

1. The Regular Army.
2. Supernumeraries.
3. The 1st Reserve.
4. The 2nd Reserve.
5. The National Guard.

1. *The Regular Army*

is sub-divided into three groups, viz.:

a. *The Volunteers*, that is to say, men from 19 to 30 years of age who enlist without awaiting their turn to be called to the colors, and those from 23 to 30 years of age who have already served their term and are desirous of continuing in the service.

b. *The Conscripts*, that is to say, young men of from 19 to 23 years who are drawn by lot from those inscribed on the communal lists.

c. *Those Enrolled*, namely, individuals called to the colors in consequence of crimes they have committed.

2. *Supernumeraries.*

The three above-mentioned groups suffice to maintain the Army at the effective required by law. Should unforeseen circumstances necessitate the increase of this effective, supernumeraries are called out. These are conscripts borne on the communal lists, but whose turn for service has not yet come. If these prove insufficient they may be augmented from the reserves.

3. *The 1st Reserve*

includes:

a. Men of 23 to 30 years who have completed the military service.

b. Young men from 19 to 23 years who have married before being called to the colors.

c. Pupils from technical schools and universities between the ages of 19 and 30 years.

4. *The 2nd Reserve*

consists of:

a. Men from 30 to 35 years of age.

b. Professors from schools, colleges, technical schools, and universities.

5. *The National Guard*

consists of:

a. Men of from 35 to 50 years.

b. Doctors and hospital surgeons.

c. Permanent judges.

d. Only sons of poor parents who are more than 60 years old.

e. Widowed fathers of minors.

f. Employés in post and telegraph offices.

g. Chiefs of offices, municipal alcaldes, etc.

Journal Royal United Service Institution, December 15, 1900.

TACTICS.

Reconnaissance and Escort for Horse and Field Artillery.

By Lieut.-Colonel A. H. C. Phillpotts, R.H.A.

During the present war in South Africa, there appear to have been several occasions on which, owing to the want of an escort or owing to misconception or carelessness on the part of the escort provided, Batteries of Artillery have been placed in imminent danger of being captured or have actually in some cases suffered the loss of guns.

This failure on the part of escorts to carry out their *rôle*, leads one to think that there must be something wrong either in the method of providing them or in their instruction, and it becomes a matter for consideration whether it would not be preferable for Artillery on all occasions to have its escort as an integral part of the unit.

It would of course on the one hand entail the permanent addition of some men and horses to every Battery, but then on the other hand it would save the cavalry being perpetually denuded of several squadrons which are withdrawn from their more legitimate work.

But if the Artillery is to provide its own escort it ought also to supply its own officers and men for reconnaissance, and this duty can nowadays after our South African experience be only properly and thoroughly carried out with the assistance of some machine guns,* such as those familiarly called "pom-poms."

A definite demand is here made to increase every Battery of Horse and Field Artillery by the addition of one Subaltern officer and twenty mounted N. C. Officers and men for reconnaissance, scouting, and escort duty.

Also to add 1-pr. Q. F. Vickers-Maxim gun drawn by six horses, with a mounted detachment of six men in charge of a sergeant.

The whole of these twenty-nine N. C. O.s and men and the pom-pom to be under the immediate command of the additional subaltern officer.

The demand for an extra subaltern per Battery may appear exorbitant at first sight, but the campaign in Africa has shown how tremendous has been the waste in junior officers and how urgent has been the demand for them.

Second Lieutenants have been drawn from garrison artillery and every available source has been tapped in the endeavor to fill gaps in the Batteries caused by the stress of war; so that even if we eliminate our present proposals there will always be plenty for this fourth subaltern to do during active service.

To thoroughly and properly train the most intelligent and active men in a Battery so that there may be always available at least twenty men and a pom-pom thoroughly fit for reconnaissance and escort duties, will be quite work enough for one subaltern officer, and he will be fully occupied in peace time as well as in war.

It may be objected that this increase of men, horses, and a pom-pom would render the command of a Major too unwieldy, but we cannot think that any officer commanding a Battery would so consider it when he thereby secured the grand end of independence and self-reliance for his command.

At present when a Battery moves away from the immediate neighborhood of the infantry or cavalry, it becomes at once liable to attack.

To descend now to a few details and technicalities.

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* Some years ago, writing in the *Broad Arrow*, I advocated having light machine guns mounted on the ammunition wagons. An effective range of say 1000 yards could be obtained with a very light machine gun, and would generally be sufficient.—Ed. U. S. M.

In order not to increase the space occupied by a Battery on the march and to make room as it were for the extra gun, men, and horses, it would be advisable to detach to the ammunition column, the store wagon and forge wagon which now, according to the arrangements laid down in the Field Service Manuals for Royal Artillery, move with the baggage and supply wagons close to the Battery.

The very few tools and materials for repair that are required for daily use by the farrier and collar maker could be easily carried in the baggage wagon which at present weighs 45¼ cwt. when packed, whereas the supply wagon when packed is put down as 49 cwt.

The weight of the baggage wagon could also be further reduced by eliminating empty corn sacks, spare horse blankets and other unneccessary things amounting to at least a hundred-weight.

As already proposed, the forge should be relegated to the ammunition column, because when marching every day, there is no time to light a fire and make shoes for horses, and carry out repairs to equipment.

The shoes would have to be nailed on cold, and the repairs would have to wait for a halt, and until a favorable opportunity offered to bring up the forge from the ammuninition column.

It has always appeared a monstrous thing to the writer, to carry about with the fighting part of the Battery, the large amount of spare article laid down to be carried in the store wagon, and it becomes a question whether this vehicle should not be abolished altogether.

In South Africa, the Batteries were constantly forced, owing to lack of horses, to leave their forge and store wagons behind, and it is believed that the efficiency of the Batteries did not thereby suffer.

And now supposing we have got these extra guns and men and horses, of what is their training to consist?

All the subalterns and as many men as possible should go through a systematic course of instruction in reconnaissance and escort duties and every gunner should be taught drill with the pom-pom.

For active service and maneuvres the officers and men who show most aptitude for the work would of course usually be taken for the duty.

The men should be armed with carbines which they would usually carry in buckets like the cavalry, but the carbines should be provided with slings, so that in presence of the enemy or on foot they could be carried on the body; swords are not required. The ammunition would be carried in a bandolier.

The men should be able in orient a map and read it quickly and with ease. Also to make a hand sketch of a road as they ride along, filling in the distances of the most important objects by the assistance of the range takers, and noting the principal features.

They must know the requirements of a good artillery position and be thoroughly acquainted with all the dodges and *ruses de guerre* to be adopted in reconnaisance.

These are the preliminaries to an engagement.

When the artillery is in action the pom-pom and escort will be on the exposed flank keeping a good look out and waiting an opportunity to cut off the enemy's scouts, giving warning of the approach of large bodies in sufficient time to enable the artillery to take measures for security.

As a rule, no Battery should go out to drill for maneuvre, without some individuals being told off for these special duties of scouting and escort. If there are not sufficient men for everything, the gun numbers must be reduced.

In all Batteries, the actual service of the guns is usually performed to perfection, but it is in the equally necessary and important matters such as patrolling, range taking, scouting, that there is a want of training.

If the three Batteries of a Brigade Division are working under the Lieutenant-Colonel, one officer would be in charge of the reconnoitring party and go with the most advanced portion of the advanced guard, looking out for artillery positions. Another subaltern officer would command the escort of about fifty or sixty men. The third would have charge of the three pom-poms which would either be formed in one Battery or dispersed* as accasion might demand.

Such, in short, is the scheme proposed in order to make the artillery more independent of the other arms and render them less liable to loss.

Guns lost after a hard struggle are an honorable loss, but at the same time so important is every gun on a modern battlefield that their loss is always serious from a physical as well as from a moral point of view.

Nothing so depresses an army or even a nation as the loss of its guns, and if anything in this short paper may assist to induce the country to provide a few more men and a little more money, these lines will not have been written in vain.

United Service Magazine, December, 1900.

ARTILLERY MATERIAL.

The Care of Guns, Carriages and Projectiles.

TO PAINT A GUN.

The brushes used should be free from hardened paint, loose bristles, sand or grit, etc. After the days work the excess of color should be rubbed off upon a clean board and the brushes places in a can or bucket with sufficient water to cover the bristles. This will prevent the brushes drying and will make them fit for use by simply rubbing the water out of them.

All old paint should first be removed from the surface of the gun before a new coat is put on. To put a new coat of paint over an old one simply magnifies all the blemishes in the old paint, such as lumps, blisters, or spots where paint has been knocked off. *To remove the old paint* it is simplest to use scrapers. A good scraper may be made from an old file by heating one end and bending it into the form of a hoe. Draw the temper to a blue and grind edge to a single and *obtuse* bevel. The corners of the edge should be rounded off to prevent a careless user from digging into the surface of the metal. The paint should not be removed from different parts of the gun at the same time. Begin, say, at the chase and finish that, then take up the rings and reenforce, etc. All scraping should be completed before painting is attempted. To prevent the exposed metal from rusting cover it with the following:

"*Rust Preventer.*"

Boiled linseed oil	1 part,
Spirit turpentine	1 part.

Apply this mixture with the bare hand and rub well. It dries in a very short time and is an excellent temporary protection. If thoroughly dry it will resist a moderate amount of rain and forms an excellent underbody for the paint. This mixture is not suited to bearing surfaces, but for trolley chains, wheel handles, rotating handles, projectiles, retraction chains, and for such bare metal as has to be handled, it will be found to be excellent. It also does fairly well for wire rope.

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* The lessons from the Boer War seem to indicate dispersion of guns in order to favor concealment from view. Dispersion over a reasonable area should not necessarily prevent concentration of fire.—ED. U. S. M.

To prepare the paint.—Open the can as furnished by the Ordnance Department and thoroughly stir the contents with a clean wooden paddle. Then strain a small portion (just sufficient for the day's work) through a muslin bag into a clean can. To obtain good results care should be taken that no lumps or "skins" get into the paint. The paint is first applied with the bare hand and clean rags. A roller bandage is excellent for the purpose. Tie the bandage together with stout twine about an inch from either end to prevent its unrolling and then remove the pins. Use the end of the bandage as a paint brush and rub the paint in with the palm of the hand, using longitudinal strokes at first, parallel with the axis of the bore. It will require several coats applied in this way to fill up the tool marks. Dents and scores are "pounded" with the end of the bandage and filled with paint and then wiped level with the surface with the hand. After the gun assumes a gray appearance the final coats may be applied with a brush.

The guns manufactured by the Ordnance Department are so roughly turned on the exterior that, if the first coats of paints are not applied in this way, the tool marks will always be visible under the paint and the gun can not subsequently be given a smooth and polished coating. If paint is supplied by brush when too thick the resulting coat will have a corded or stringy appearance. A poolish applied to such a surface will only magnify this defect. If for any reason the final coat of paint is not perfectly smooth it may be rubbed down with *powdered pumice* and water. Individual lumps or ridges may be rubbed down with a block of pumice. If paint is applied when too fluid it will run dry in waves or ridges. If in rubbing down with pomice the metal is exposed it will not do to put a patch of paint upon the bare spot. That part of the gun (chase, reenforce, etc.) must receive an entire coat. After using pumice the surface of the paint, though perfectly smooth, loses its gloss. It must therefore be polished with

"*Gun Polish.*"

Crude Petroleum	1 pint,
Boiled linseed oil	1 pint,
Japan Dryer	1 pint.

Thoroughly mix before using. Keep it in screw-top cans or in bottles whose *corks have been steeped in petrolatum.* It is worthless if allowed to become gummy. To use, apply a very little at a time with the palm of the hand and rub, Rub, RUB. An 8-ounce bottle of this will probably suffice for one coat for a 10-inch gun. Apply several coats and rub down with fine canvas (or duck) belts. The effects of this polish upon *bronzed* steel is very pleasing, giving the appearance of polished mahogany.

TO PAINT A GUN CARRIAGE.

First plug all oil holes with wooden pegs. These plugs should be long enough to afford a good handle and sufficiently conspicuous to insure their not being in the holes after the paint is dry. Next with clean waste wipe off all oil and grease and then with clean waste sponge the surface with benzene, paying particular attention to the greasy spots. Paint may then be applied after taking the precaution to mix and strain it as in the case of the gun. If the old coat upon the carriage is in good condition, that is, smooth and free from scales and blisters, it may be freshened by applying paint with clean muslin rags. A very little paint thus applied will cover the surface and give a pleasing appearance to the eye. If the old coat is scaly it must be scraped off. In this case, before applying a new coat, first give the carriage a coat of boiled linseed oil, applied hot.

In applying hot applications of oil or cosmic the blow-lamp of the oil engine will be found a convenient source of heat. Make an iron tripod to fit over it and you have a convenient portable fire.

PAINT REMOVER.

Lye is sometimes used to remove paint but its use is attended with some danger to person and clothing. Its use is to be avoided if scraping can be resorted to. The following is said to be superior to pure lye and possess the advantage of being harmless to human flesh:

"*Lye Paste.*"

Caustic Soda (98%)	1 pound.
Water	1 gallon.
Mineral Oil	1 pound.
Saw dust	1 pound.

Dissolve the soda in the water, then add the oil and stir till the emulsion is complete. Then add the sawdust to form a paste. Brick dust or powdered pumice, may take the place of saw dust. Much stirring is require to emulsify the oil. Anyone who has seen the old fashioned method of churning will know how to proceed. A mechanical stirrer may be rigged in connection with the oil engine. After the paste is mixed it should be passed through a paint mill. A meat grinder would serve this purpose. To use this paste apply it with a brush, or swab, to the paint or varnish to be removed and allow it to act for several hours.

PAINTS.

Linseed Oil forms the base or liquid of all paints. The are two varieties in use, viz.: (1) Raw Oil, which is light in color and which is the natural oil of flaxseed, and (2) Boiled Oil, which is dark in color and which is obtained, as its name implies, from the raw oil by boiling. The raw oil is heated above 500 Far. and from 1% to 2% oxide of lead (either peroxide or protoxide, commonly called litharge) added, together with a small proportion of oxide of manganese. The hot oil combines *chemically* with the oxides thus dissolved in it. Raw oil dries slowly (5 or 6 days). Boiled oil dries quickly (24 hours). The term "dries" is misleading as the hardening of the film is due to *oxidation* and not to evaporation.

Test for Linseed Oil. Equal parts of Nitric Acid and Oil are well shaken together and afterwards allowed to stand for 20 minutes. If the oil is *pure*, the upper stratum of the mixture will be *straw yellow* and the lower *colorless*. If the oil is *impure* the upper stratum will be *dark brown* or *black* and the lower stratum *yellow* or *orange*.

Adulterants commonly mixed with linseed oil are *fish-oils* and *mineral oils*. These are worthless as they do not form a film and the coloring matter has nothing to bind it.

DRIERS are used to hasten the formation of a film. Turpentine, Benzine and Kerosene are commonly used. If from 5% to 15% of Turpentine is added to paint, the latter may be handled in 24 hours after spreading. Turpentine does not hasten oxidation but thins the film and thus acts mechanically. Excess of Turpentine dilutes the oil to the extent of making it incapable of cementing the pigment. Benzine and Kerosene are cheaper and inferior driers. If too much drier is used the paint rubs off or "chalks."

PIGMENTS added to linseed oil serve three purposes in the way of preservatives, viz.:

1. They harden the oil film.
2. They thicken the oil film.
3. They reduce the porosity of the oil film.

The pigments used upon metals are the following:

White lead: Lead hydrate and carbonate. Usually sold mixed with raw linseed oil, 9 parts of lead to 1 part oil, by weight.

Zinc white: Oxide of zinc. Not so opaque as white lead, has a tendency to scale off. A mixture of white lead and zinc white is better than either alone.

Chrome yellow: Chromate of lead.

Prussian blue: Ferryocyanide of iron.

Ultramarine blue: An artificial and secret production.

Red: Sesquioxide of iron (hematite) and hydrated susquioxide of iron (limonite) or a mixture of the two.

Venetian Red: An artificial production containing sulphate of lime. Not desirable on metal.

Black: From carbons,—graphite, lamp black, bone black.

Tints and shades are made with white lead as a basis with other pigments or mixtures of pigments added. White lead is adulterated with kaolin, barytes and whiting (carbonate of lime). The first two are worthless as pigments, while whiting is actively injurious.

RED LEAD: Is a basic substance that combines chemically with the oil. It is midway between paint and cement. It is used as a cement to tighten screw joints by plumbers and steam fitters. It is composed of a mixture of peroxide of lead and protoxide of lead (litharge). The peroxide is the characteristic ingredient. It hardens in long standing and should be used when freshly made. After spreading, it tends to turn white with age. It is generally covered with ordinary paint.

Comparative Table of Emery Cloth and Emery Paper.

Number on paper or cloth.	Grade of emery used thereon.	Equivalent cut of file.
00	" Flour."	Dead smooth.
0	No. 120	Dead smooth.
½	" 90	Superfine.
1	" 80	Smooth.
1½	" 70	Smooth.
2	" 60	Second cut.
2½	" 54	Second cut.
2	" 46	Second cut.

No. 40 emery equivalent to the cut of a Bastard file.
No. 30 " " " " " " " Rough " (ordinary).
No. 20 " " " " " " " " " (coarse).
No. 10 " " " " " " " Wood rasp.

Corundum is sharper than emery but not as hard.

COLORS.

The Primary colors are: Red, Blue, Yellow.

The Secondary colors are: Green, Orange, Violet.

The Tertiary colors are: Russet, Olive, Citrine.

The Secondary colors are obtained by mixing two Primary colors together.

The Tertiary colors are obtained by mixing two Secondary colors together.

It will be seen, therefore, that each tertiary color contains all three primary colors with an excess of one of the primaries.

COMPLIMENTARY COLORS : The complimentary color of any primary is composed of a mixture of the two remaining primaries : thus Green (Blue plus Yellow) is the compliment of Red, &c. Where two colors are to be used on the same surface, or in juxtaposition, the colors should be compliments of each other to from a pleasing contrast to the eye.

CAPTAIN HAMILTON ROWAN, ARTILLERY CORPS.

(To be continued.)

A Portable Folding Forge.

The novel portable forge here illustrated was primarily designed for use on shipboard, and especially on battleships, cruisers and other naval vessels. Its convenience and ready portability, however, adapt it to a wide range of uses, and its applicability for field and camp service are so evident, it has been named the Army and Navy forge. When ready for use—as shown in Fig. 1— the rigid steel plate case provides a commodious hearth, standing about 30 inches above the ground. To this case are removably attached the gearing, blower, tuyers and supporting legs, the latter fitting into sockets at the corners of the case and having their lower ends flanged so as to give support. An 8-inch crank and handle operates the blast-wheel of the blower, through a

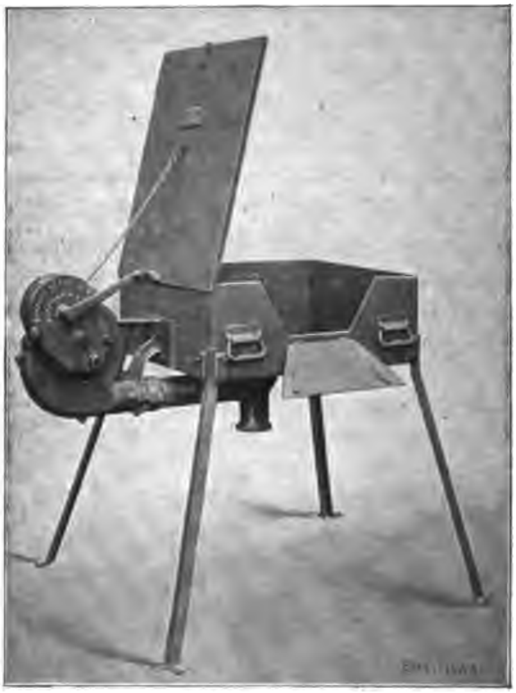

Fig. 1.– Army and Navy Forge : Set up Ready for Use.
Buffalo Forge Co., Buffalo, N. Y., Makers.

train of four accurately cut gears enclosed in a dust-proof case. The tuyers pipe, connecting the blower with the circular tuyers-plate, has a short drop branch for the collection of ashes. To facilitate the handling of long bars, a section on each side of the case is hinged so that it may be turned down; and the raised cover acts as a wind-guard when the forge is in use.

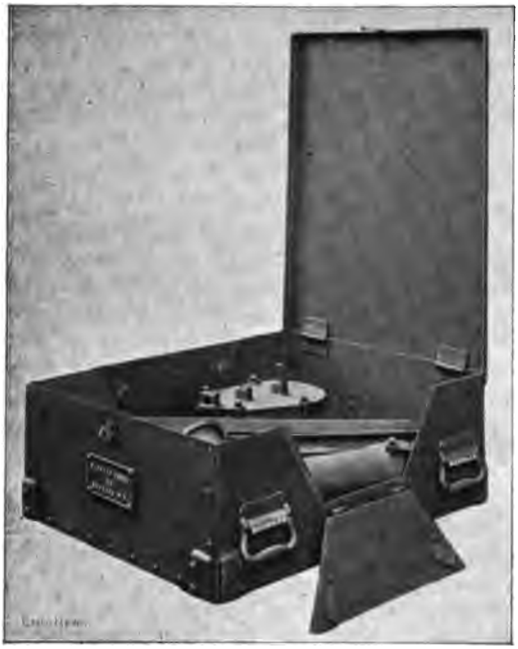

Fig. 2.—Army and Navy Forge; Taken Apart and Put in Casel.

Fig. 2 shows the several parts packed within the case, leaving additional space for blacksmith or farriers' tools. Fig. 3 shows the forge packed for transportation, and the outside dimensions of this closed case are only 27½ inches long, 22½ inches wide by 10 inches deep, with a total weight of 164 pounds. A hasp for pad locking the case and four handles for lifting com-

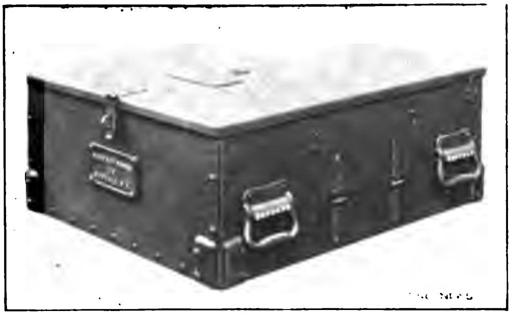

Fig. 3.—Army and Navy Forge; Packed Ready for Transportation.

plete the outfit. This forge has been designed and placed upon the market by the Buffalo Forge Co., of Buffalo, N. Y., and we are indebted to that company for the photographs from which our illustrations are reproduced. We are informed that the forge is already in extensive use. Besides the sales in this country it is being introduced abroad and is in use in the Japanese Navy.

It has been recommended for army use by the Quartermaster General of the United States Army, and finds much favor with minors, prospectors, bridge builders, contractors and others.

—*Engineering News*, December 6, 1900.

Modern Artillery.*

By A. T. Dawson, late R. N.

Modern Artillery is a very complex subject, for in the attachment of that great power and precision which characterise the present-day artillery, notwithstanding the minimising of its weight, there have been introduced innumerable yet indispensable details, each the result of patient research on the part of our greatest scientists, and the production of the highest mechanical skill. So numerous and interesting are the problems involved that in a reasonably brief lecture one can only touch the fringe of the great subject.

It is quite impossible to enter into detail, and I therefore propose, after briefly considering general governing principles, to select certain types of ordnance, both British and foreign, in order to point out specific differences and to compare generally the different systems employed, with the view, if possible, of ascertaining relative advantages and disadvantages.

Having regard to the present important position that artillery holds in all countries, and to the direct relation which the possession of a sufficient number of efficient weapons bears to the safety of an empire, I feel that I shall be excused at the outset of my address in seriously pressing home to the public mind, through the medium of this influential society, the necessity of the British Empire placing the most modern and effective of weapons at the disposal of our brave sailors and soldiers wherewith to defend in times of necessity, the integrity, the independence, and possibly even the existence, of our Empire.

I do not wish to pose in any way as an alarmist, for I am sure that the Government are endeavoring to do all that practically lies in their power to put our sea and land defenses in order, but having regard to the activity that the other great nations of the world are showing in the employment of the most modern arms to the exclusion of inferior and obsolete weapons, it is the duty of all to be incessant in their support of Government measures to place our land defences, as well as our fleet, in possession of artillery second to none in the world.

Warships with Muzzle Loaders.—I shall not in this somewhat brief address refer to the muzzle-loading guns, of which, alas! we still have many remaining—both in ships and forts; but while my main pnrpose is to consider the more modern pieces of ordnance and their equipments generally. I would like to point out that I consider that in the present day of modern artillery, a badly-armed ship is, from a fighting point of view, worse than useless to the country, because if it happens to come into the line of battle, it would be put out of action by a ship perhaps only armed with a few modern guns, with possibly no armor protection and manned by a very scant crew, providing always she has the speed and is able to control the range.

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* Paper read at the Society of Arts on March 6.

I will take as an example the *Inflexible*, which we may consider heads our long list of vessels armed with muzzle-loaders, and assume for the sake of illustration that she came across a French cruiser, say, of the Cassard class. The *Inflexible* has a crew of, say, 485 men, as against the 385 men of the French cruiser. She cost (it is true, many years ago) about a million sterling, as against the 318,000*l*, of the French ship. Now, at a range of 8000 yards or more, the French ship would be in safety against the fire of the *Inflexible's* guns ; whereas at this range the French cruiser, with the aid of her modern guns and of modern telescopic sights, would be able to make good practice against the British ship, and, in my opinion, would put her quickly out of action by firing large capacity high explosives and other modern shells.

Let us, from this particular illustration, consider further the cost to the country. Each man employed on board ship costs us about 100*l*. per annum, and thus the wages bill for 485 men is at the rate of 48,500*l*. per annum. The upkeep during war of a ship of the *Inflexible* class in the expenditure of coal alone, since it would be at famine prices, would be enormous, and the cost of repairs, &c., greatly disproportionate to the services rendered.

But, apart from these monetary items, there is the far more important question of the ineffective employment of the 485 men, whose training represents a large national asset. And what would be still more deplorable, from more views than one, if these obsolete ships, of which there are very many in the service, are sunk or taken, a very large and very unpleasant gap would be made in our *personnel*.

Other similar illustrations might be given, but the one surely affords strong reason for selling the old obsolete ships and expending no more money on them even in peace times, or for arming them with modern artillery. The latter course seems to me more advisable, as armaments of a kind can be provided much more quickly than new ships to replace the old vessels, and history has shown the value of reserve ships to fill up gaps in naval warfare, even if they be not quite up to the mark from a ship construction point of view. The nation which can more expeditiously challenge anew the enemy after a hard fought battle is the more likely to succeed ultimately.

Quick-Firing guns for Fast Merchant Steamers.—The power of the unarmored ship of great speed and high gun power to control the range, to which I have been referring incidentally, represents the importance of the armed merchant transports, and enforces the value of the mercantile fleets possessed by maritime nations, of which we are the greatest. For my own part, I would advocate that all ships sailing under the British flag over a tonnage of, say, 3000 tons displacement, and having a speed of, say, 17 knots, should be called upon to have suitable deck attachments for the accommodation of 6-inch quick.firing guns. The inconvenience in peace time would be inappreciable, and the extra cost and weight necessary for strengthening the forecastle deck during construction would not materially affect the price or weight of the ship—it could be done at a very small extra cost. Such ships would be invaluable to the Admiralty as armed cruisers in war time, if there were provided at convenient ports really modern 6-inch or higher-powered guns to instal on board them. I mention this particularly because I am sure we have not at the present time a reserve of really modern long range artillery suited to this and other purposes, the need for which must inevitably arise during the progress of a war.

Principal Factors in the Evolution of Modern Artillery.—I would like to turn now more directly to the principal factors which have brought about the evolution of modern artillery. And first in importance must be placed improvements in propelling agents in powder. The modern smokeless propellants have entirely altered the conditions of modern warfare and have done most to render obsolete artillery weapons useless and dangerous to the nation which does not keep pace with the development of modern artillery enterprise. The initiation of modern explosives has made it possible to more than treble the energies of guns as compared with the days of black powder, bringing into the arena of practical warfare long range fighting by land and sea, such long range fighting being rendered accurate by the use of telescopic sights, range-finders, &c.

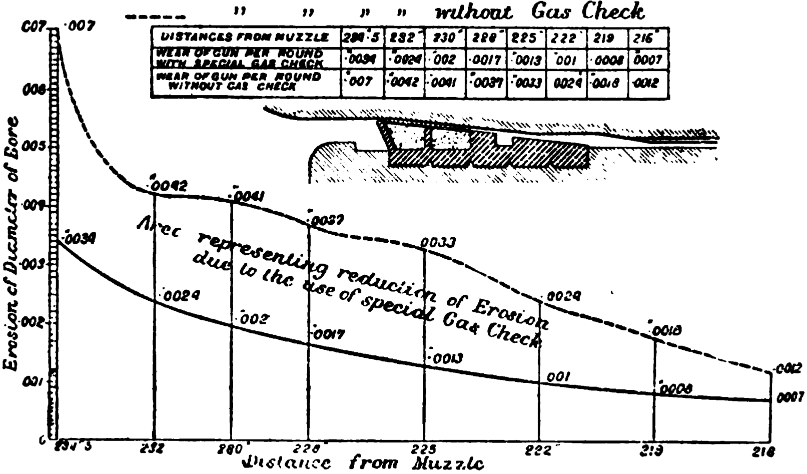
Secondly, it has rendered a very great rate of fire possible, owing to the smokelessness of the powder, the object aimed at being practically visible at all times. Furthermore, there is no residue left in the gun; therefore, as soon as one cartridge is fired, another can be put in without the elaborate sponging, &c., required with the old powders. This also facilitates considerably a quick rate of fire. There are, of course, a great many other advantages which may be credited to the initiation of smokeless powders, but the two great advantages resulting therefrom are really higher energies and a quicker rate of fire. In field operations, even more than at sea, the strategical advantages of smokeless powder are invaluable and more or less obvious, so that they need not be enlarged upon.

Smokeless Powders: Cordite versus *Nitro-Cellulose.*—Having laid stress on the importance of smokeless powders in connection with modern ordnance, it may be well to say a few words on the explosive compounds themselves. In the days of black powder the velocities were limited to about 1600 foot-seconds, owing principally to the quick rate of burning of the powder. The modern propelling powders, such as the various forms of nitro-cellulose and nitro-glycerine, are much slower burning, and thus longer guns can be utilised in which a greater number of expansions of the gas are obtained, thereby increasing the velocity to a very much greater extent, in many cases up to 3000 foot-seconds. As to the type of powder to be used as a propellant, there is now practically no difference of opinion throughout Europe and America, nitro-cellulose being preferred on all hands. The United States, Russia, and France have adopted the nitro-cellulose form for some time. Germany has been late in its adoption, having used a form of nitro-glycerine powder containing about 25 per cent. nitro-glycerine, but has now practically, I believe, decided to adopt a nitro-cellulose powder. Other small countries in Europe have not definitely decided on a particular type of explosive, and may be said generally to be carrying out experiments. The fact, however, of nearly all the great countries of the world, excepting our own, having adopted it, is to some extent the reason why our own Government should give it the greatest consideration. At the present time Great Britain is using cordite containing about 57 per cent. of nitro-glycerine. This powder has now been in use for about nine years, and in its day may be said to have been one of the best known explosives at the time of its introduction: it was absolutely necessary for our naval supremacy to introduce a smokeless powder; hence, I would represent that at that time Great Britain acted advisedly. The experience of the French until quite recently cannot be said to have been highly satisfactory, as we all recall the serious explosion at Toulon not many years ago, which we have every reason to know was due to a deterioration of the powder in storage. Furthermore, I understand that the Russian Government's experience until three or four years ago was not all that could be desired, the nitro-cellulose from which it was made not being of the finest quality. In the United States they have now generally adopted nitro-cellulose powder in the their fleet and are introducing it into their land service. I understand the experience with this powder in the United States Navy is everything that could be desired, although I believe they are constantly carrying out experiments with a view to improvements. The United States Land Service, however, have until quite recently used a nitro-glycerine powder containing about 10 per cent. nitro-glycerine. The experience they have had with their powder has been anything but satisfactory, and on their many occasions they have had serious high pressures in their guns, in some cases completely destroying the artillery using it. The experiences of foreign Powers tend to show the wise policy of the British Government in not adopting a nitro-cellulose powder at the time of its original initiation. Since that period, however, the manufacture of nitro-cellulose powders has very greatly improved, and the powders now being adopted by Russia and Germany are quite as safe in their use as cordite and other known modifications of cordite having various per centage of nitro-glycerine.

Nitro-cellulose powder has the great advantage of being capable of producing in modern artillery the highest possible ballistics with the least possible amount of wear to the gun ; and therefore at the moment its introduction should be treated from a most serious standpoint. It is, I think, well known to all of you that the temperature of explosion of cordite is practically double that of nitro-cellulose powders. This great temperature of explosion has a great bearing upon the wear of guns, for with so high a temperature of explosion as cordite far exceeding the melting point of steel, it is not reasonable to expect a gun to last for many rounds, and especially if large charges are used, developing heavy volumes of gas. Now, in order to obtain high ballistics, it is very necessary to develop very large quantities of gas, with the view of keeping volumes of expansion of the gas at the higher pressures to the muzzle of the gun. If cordite is used, having this very high temperature of explosion, these volumes of gas at the high pressure must of necessity seriously affect the bore of the gun, especially at the commencement of the rifling. The nature of the wear of the bore with cordite is also very serious, taking the form as it does at the commencement of erosion of very thin fine lines, which develop as the rounds are continued, completely washing away the surface, and quite abnormally enlarging the seat in the gun, where the shot is rammed home. This, after a few rounds, allows the shot to be over-rammed, increasing the volume of the chamber, which, in its turn, diminishes the pressure, reducing the energy of the gun, and varying the velocities, and therefore the range, accuracy, and, indeed, every point which to the gunner is an absolute essential. Furthermore, the wear of the bore of the gun prevents the proper centring of the projectile at starting, causing it in many cases to gyrate when it comes under the influence of the rifling. In guns of low power using cordite, where only small charges are required, the effect is, of course, much less than in guns using large charges; but I contend that as it is necessary for modern artillery, except that for special purposes, to have the highest possible ballistics, it is of primary importance to use a powder which, as far as possible, gets over the objections I have just mentioned. The effect of using cordite in, say, 6-inch high-powered guns having velocities of 2800 feet to 3000 feet, is to entail a loss of some 500 to 600 foot-seconds, after about 200 rounds have been fired, representing a loss of energy of about 34 per cent., owing to the development of erosive effects. Furthermore, these velocities vary very materially with the temperature, and in some guns as much as 3 feet for every degree Fahrenheit. The question really comes to this : that if cordite is used, no higher velocity than, say, about 2500 feet can be obtained for any reasonable number of rounds, whereas with nitro-cellulose powder, velocities up to and exceeding 3000 feet can be easily obtained, without the objections attendant on the use of cordite. I therefore shall continue to urge that a nitro-glycerine powder is not suited to modern artillery, and that any country continuing to use it must of necessity be at a serious disadvantage with a country making use of a nitro-cellulose powder. The effects in other countries of powders containing from 10 to 25 per cent. of nitro-glycerine have, from an erosion point of view, been superior to those containing a higer proportion, but with such a powder a much larger charge has to be used in order to obtain the same ballistics, and the saving in erosion is not so great as one would naturally in the first instance think. A certain increase in the life of a gun can be gained by using an efficient gas check, and my diagram (Fig. 1) shows the advantage of using the special form of gas check shown thereon for making a metallic seal of the gas at the commencement of the travel of the shot and continuing it throughout the bore. The advantage of using such a gas check is to lengthen the life of the gun, but it will have much more valuable results if used in conjunction with nitro-cellulose powder than with a powder containing any percentage of nitro-glycerine.

DIAGRAM SHOWING DIFFERENCES OF EROSION PER ROUND FIRED IN A 6 INCH GUN WITH AND WITHOUT SPECIAL GAS CHECK

Fig. 1. ——— Shows Erosion of Gun with Special Gas Check
- - - - - " " " " without Gas Check



DISTANCES FROM MUZZLE	234·5	232	230	228	225	222	219	216
WEAR OF GUN PER ROUND WITH SPECIAL GAS CHECK	·0034	·0024	·002	·0017	·0013	·001	·0008	·0007
WEAR OF GUN PER ROUND WITHOUT GAS CHECK	·007	·0042	·0041	·0037	·0033	·0024	·0018	·0012

Erosion Results with Krupp Gun.—As an example of the small erosion in guns when using a nitro-cellulose form of powder. I would refer you to an experiment carried out in a Krupp 6-inch gun, in which—after some 534 rounds, 76 of which were fired with prismatic powder and ballistite—the dimensions of the bore were such that notwithstanding the damage done by the seventy-six rounds of powder, other than nitro-cellulose, the dimensions of the gun came within the acceptance limits of a new gun. It is only right, however, to add that in this gun the velocities were not very high, being only 2500 foot.seconds ; but even this velocity is higher than that of the majority of 6-inch guns we now have in the service. (See Fig. 10).

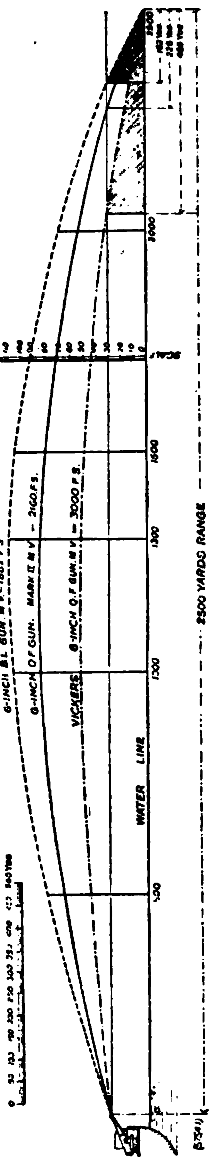

6-INCH BL GUN. M V.- 1862 F.S.
6-INCH Q.F GUN. MARK II M V - 2160 F.S.
VICKERS 6-INCH Q.F GUN. M V - 3000 F.S.
WATER LINE
2500 YARDS RANGE
120 FEET
SCALE
0 50 100 150 200 250 300 350 400 450 500 YDS
2000
1800
1500
1300
500

Fig. 2. COMPARISON OF DANGEROUS SPACE USING 6-INCH SERVICE GUN

The usual objection put forward to the introduction of a nitro-cellulose powder is that it will not keep on foreign stations with variable climates. This I must state is erroneous ; I have results of nitro-cellulose powders stored in some of the hottest climates, and these have proved in every way satisfactory, both chemically and ballistically, when fired in guns. Some of the great German makers have had this powder under various heat tests for many years, and have reported to me their definite opinion that nitro-cellulose powders if properly made, are to be relied upon not to deteriorate any more than cordite and other nitro-glycerine powder when subjected to variable climatic influences.

I have heard it sometimes said abroad that better ballistics can be obtained in a rifle using nitro-glycerine powders as against cartridge made up of nitro-cellulose powders. This belief is unfounded, as I have been able to obtain from rifle cartridges of the smallest size used in Europe higher ballistics with nitro-cellulose powder than with cordite at normal temperatures, say, between 60 degree and 80 degree Fahr.

Having laid particular stress on the importance of nitro-cellulose powders, because they are the only ones by which we can obtain constant high velocities up to say 5000 foot-seconds, I will now call your attention to my dangerous space diagram, showing the difference between the effect of firing with a high velocity and with a low velocity (Fig. 2).

Accuracy of Fire : Telescopic Sights.—I would point out that with modern ships steaming, say, at 20 knots, the variation in distance per second is very great, and therefore from a naval point of view the importance of the flat trajectory cannot be over-rated.

Having generally dealt with the question of high powers produced by powders in guns, I would now devote a few minutes to the consideration of accuracy, and I would at once say that in order to obtain real accuracy under general service conditions, one of the main considerations is the obtaining of a powder which does not cause variations in ballistics, either through change of temperature or damage to the bore of guns, Without this, no artillery, either field or naval, can be seriously relied upon, and this point is closely considered in all the great countries in Europe. The other consideration in regard to accuracy, is the type of sight made use of with the gun, whether for field or for naval purposes, and I would at once call attention to the great advantage of using a really good form of telescopic sight, in conjunction with any long-range firing. I am sure that this would tend to lessen the waste of ammunition, and to insure 50 per cent. better accuracy than is the case in artillery not making use of telescopes. I am inclined to think that the old form of sight, in which the tip of the foresight is brought in line with the

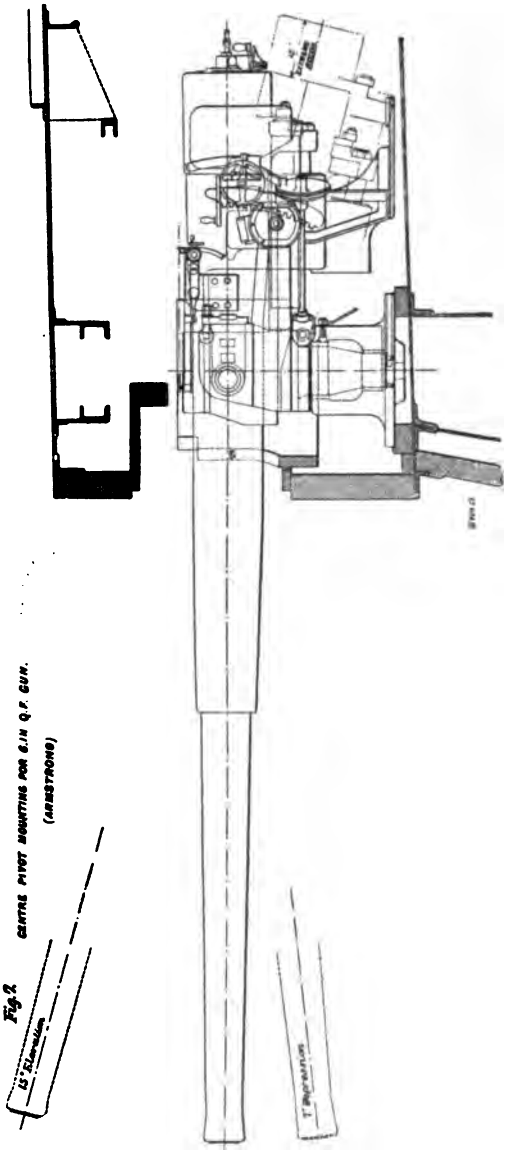
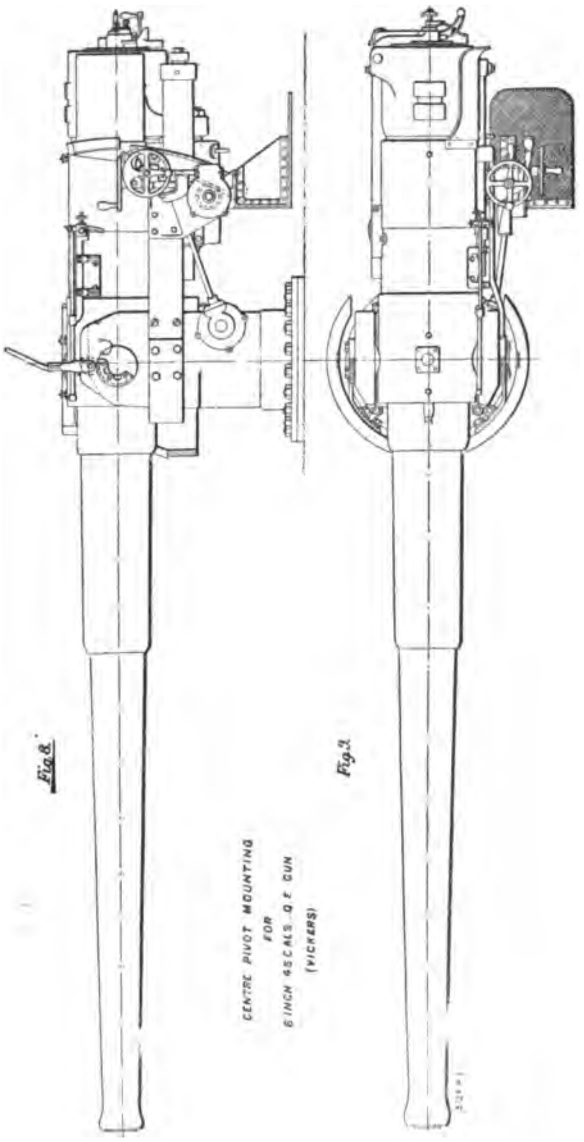


Fig. 2. CENTRE PIVOT MOUNTING FOR 6.IN Q.F. GUN. (ARMSTRONG)

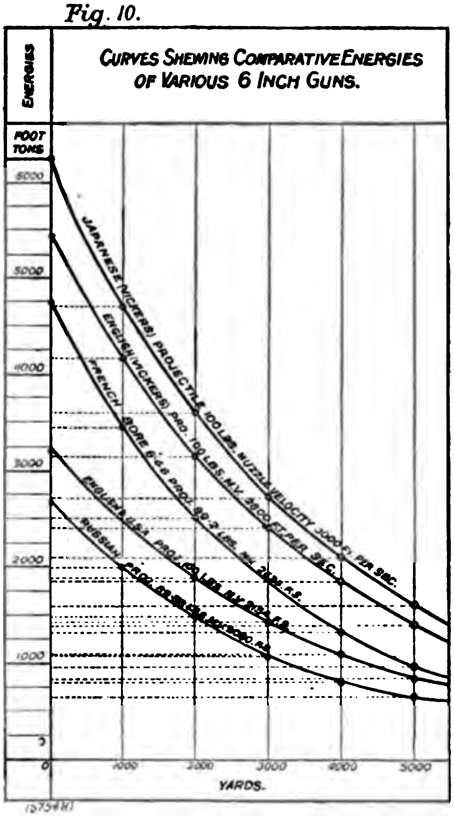
object through the notch in the back sight, is a thing of the past. The question of the eye having to focus itself on three different points, and bring them into line, is of necessity difficult, and must tend to great inaccuracy. With a telescope these objections are nearly overcome, although it is difficult and



somewhat complicated to make the cross wire of the telescope in focus with the object aimed at. This may be possible with one particular man, but will require adjustment for all different sights. Sir Howard Grubb, of Dublin, has invented a sight in which he has been able to devise an arrangement by which an imaginary image, which is practically in focus with the object aimed at, can be brought into the alignment, so that no parallax is caused in the eye, thus rendering the sighting very simple. I am quise sure that the importance of giving special consideration to forms of sight is one of the first duties of the gunner, and cannot have too much attention paid to it.

Providing now the power, constancy in ballistics, and the aim of the gun is correct, we must turn attention to the consideration of the mounting of the gun, either for sea or land service. There is no doubt that the gun, which is designed to move axially with its bore, with as little jump as possible, will give at all angles of elevation the best results, and this is certainly a point which should be considered in the general construction.

Fig. 10.



In both land and sea service artillery, I am of opinion that this is the reason why the recoil of the gun should be taken by some form of hydraulic cylinder which at the first movement of the gun reduces the strains on the material, allowing the gun to recoil axially, without any important movement of the carriage. Of course the conditions under which these guns are worked are very different, and I would first like to say a few words on the question of the mountings and general equipments of sea service artillery.

Sea Service Ordnance.—I will in the first place deal with a type of mounting very generally used by most of the countries of Europe, for the purpose of mounting 15-pounder and smaller guns. As the weapons are largely used for resisting torpedo-boat attack, they can hardly be said to enter into the main armament of a battleship or cruiser, although they are very useful for gun-boats and the smaller types of ships which are not equipped to fight in the line of battle. The Vicker's-Maxim type has been generally adopted by Spain, Argentine, Russia, Brazil, and Belgium.

I come now to a type of gun in general use by all countries of the world—namely, the 6-inch quick-firing gun. The first of this type was originally introduced by the late Lord Armstrong, to whose great inventive genius and mechanical skill the world has recently paid a full-hearted and well-merited tribute. I give as an illustration of one of these guns, a copy of a picture from Brassey's *Naval Annual*, which shows the general arrangement in detail (Fig. 7). I also show another mounting of Vicker's type now being put into many of our battleships and cruisers (Figs. 8 and 9). As great a number as 11 rounds per minute has been obtained from this gun, with velocities in some cases of over 2800 feet. A novel point in connection with the mechanism is the special form of Vicker's breech screw, which is threaded at varying radii by which, in this particular gun, two-thirds of the circumference are screwed, and only one-third non-screwed. By this design the screw has been lightened to the extent of about 46 per cent. less than the ordinary service breech screw previously utilized for this gun. The diagrams demonstrate this wonderful reduction in weight caused by the modified form of screw, which has now been adopted in many countries of the world including Great Britain, United States, Japan, and Spain, and I believe, in many German field guns. Fig. 10 is a diagram of the power of different types of 6-inch guns.

I come next to a form of twin 6-inch mountieg, which enables both guns to be fired either separately or simultaneously. In this mounting both guns are elevated and trained together and manipulated from either of the sighting positions. The feature of this mounting is that it admits of the concentration of a very heavy rate of fire from a specially protected gun position. The protection of such gun positions, including the ammunition supply, is now of vital importance in modern ships. and is receiving much attention from all countries. The powder ammunition supply admits of a continuous rate of supply being carried to the right and left guns, the projectiles being lifted from the shell carrier which revolves round the mounting.

The next gun I would like to refer to is the weapon of 7½-inch calibre, which is now being very generally adopted all over the world. (See *Engineering*, vol. lxix, page 745). Two of these guns may be mounted in a barbette and arranged to be supplied with ammunition by hydraulic power. The weight of the projectile for the guns recently constructed for the British Government is 200 pounds, which can easily be lifted by two men. This gun is therefore one of the heaviest quick-firers now in use. It is capable of firing at the rate of nearly six rounds per minute, which means a collective striking energy of 75,000 foot-tons for every minute the gun is in action. The velocity of the gun, using nitro-cellulose powder, is 3000 foot-seconds.

I will now come to the heavier types of ordnance of from 9.2-inch to 13-inch calibre.. In selecting the various types of mounting, I have chosen those in which different sources of power are utilized, in the hope that the discussion after my lecture may be directed to a consideration of the relative advantages of the different systems. The power by which heavy ordnance, mounted on board ship, should be worked admits of much discussion; but for my own part I am prepared to vote for hydraulic power for the heaviest ordnance, while I think advantages accrue from the use of electricity for the lighter types. In the very heavy ordnance it is almost necessary to use other power than springs for the running of the gun to the firing position, as the springs employed require to be very heavy, and thus prove cumbersome, necessitating a large port. If, on the other hand, electrical power is utilized, it is necessary to adopt some other system (1) running the gun out, and (2) taking the energy of recoil. If electric power is used for the heavy ordnance, it is generally necessary to embody hydraulic of hydro-pneumatic cylinders in combination for the two operations stated. This involves complication to some extent, and the necessity for greater skill in manipulation. Whatever system be used, I am strongly in favor of having as an alternative mechanical devices operated by hand, in the event of any derangement, especially in action, of the power gear in use.

The first type of 9.2-inch mounting I would like specially to call attention to is one of the latest designed by Krupp, of Essen. The gun is of 40 calibres as against 45 now being used by the British service. The mounting is elevated and trained by electricity, but the rammer is operated by hydraulic power, this power being brought into the barbette by means of flexible hydraulic piping, the flexible piping doing away with the necessity of elbow joints, etc. The recoil is taken by a hydraulic cylinder, a portion of the liquid of which is used for compressing air which stores up a portion of the energy, which is afterwards used for running the gun out to the firing position. In normal times it is necessary to lay the gun to a fixed angle for loading.

The ammunition supply is worked electrically, alternative hand-power being also provided. The mounting, from a general point of view, is extremely well designed, and should admit of great efficiency. I will not, however, disguise the fact that, after studying this type of mounting, I am strongly averse to the complication arising from the use of a combination of electricity, hydraulics, and hydro-pneumatic power.

I will now refer you to a 9.2-inch gun mounted on the Vickers system, being supplied to the Turkish Government. It is worked entirely by hydraulic power, and is very similar in construction to that now being designed for the British Government.

I will not, however, describe this mounting in detail, but proceed to the Vickers system of mounting two 12-inch guns. This is quite a novel type of mounting, admitting of the loading of the gun at any angle of elevation, as well as at any angle of training, so that during the operation of loading the gun layer is able to accurately sight the two guns, and thus immediately the one, or both, are loaded, they can be fired. Arrangements are made that a supply of ammunition is continually being conveyed through the ammunition trunk so that the cage which travels on the arc, cut concentric with the trunnion of the gun, is always kept filled, and thus immediately the gun is fired the cage can be raised into the loading position ready to insert a new charge. This mounting differs from many at present being used in Europe in respect that, when the ammunition cage is brought up to the gun, it is automatically kept in a fixed position relative to the axis of the gun during the movements of the mounting in elevation. The system lends itself well to the general quick-loading principles applied to the heaviest types of ordnance. Two rounds per minute from each gun can easily be obtained in actual practice.

Five British first-class battleships now building are being fitted with these mountings, making their heaviest guns really quick-firers.

I would remark, in the conclusion of this portion of my lecture referring to heavy artillery for sea service, that I think the Admiralty are to be congratulated on the efficient mountings of artillery in their modern ships, and in making this remark, I include not only the mounting which admits of the gun being loaded at any angle of elevation—a characteristic of the Vickers type, and which I consider to be one of the most advanced, but I also refer to the excellent hydraulic and electric mountings supplied by Messrs. Armstrong, Whitworth, and Co., to the British Fleet.

Although I have, perhaps, in my lecture, dealt more with equipments supplied by the Vickers-Maxim Company, I would in no way let it be thought that I do not attach the greatest possible importance to the efficient and cleverly worked-out material supplied by the great Newcastle firm, from whom British modern artillery may be said to have received the greatest impulse during the last century, and of which that eminent artillerist, Sir Andrew Noble, is the head. —*Engineering*, (London).

[TO BE CONTINUED.]

SMALL ARMS AND EQUIPMENTS.

Laflin and Rand Powders.

April 16, 1901.

Laflin & Rand Powder Co.,
99 Cedar Street, N. Y. City.

Gentlemen :

Our Boston correspondent informs us that on Saturday last, Mr. Thomas Anderton, the famous revolver shot, broke the 100 shot amateur revolver record of the United States, scoring 915 points, which is 12 points higher than the previous record. Mr. Anderton's cartridges were loaded with 45 Caliber Laflin & Rand nitro powder.

I thought you would be glad to hear of this victory for your powder as soon as possible.

Score with Laflin & Rand Smokeless Powder.

In connection with the finish of the Grand American Handicap at Interstate Park, Queens, L. I., on April 5th, was the remarkable score made by Mr. F. S. Parmelee, who won the highest general average for the entire week.

It was on the second day's shot, the Nitro Powder Handicap, that Mr. Parmelee lost his first bird. This makes a remarkable score wherein Mr. Parmelee killed 106 out of a possible 107 birds. This shooting was achieved by Mr. Parmelee using the following load : 42 grains L. & R. Smokeless Shotgun Powder.

This was accomplished during a week of most inclement weather and when the conditions were anything but favorable for marksmen to make high scores. This adds another victory to the long list that have already been won for L. & R. Shotgun Smokeless, which has become very popular with sportsmen throughout the United States and Canada.

Field Glasses for Service.

By Major G. Osborn, R. A.

The present war has made all ranks feel the value of good field glasses.

Smokeless powder renders the field of view clear, and yet, owing to the increased length of the range of effective fire, it is more difficult than ever to locate the enemy, unless he is quite out in the open.

A bullet now travels quicker than sound, so that the first intimation of danger is often the whistle of a bullet close by, or the sting of a bullet actually striking.

Hence any means of increasing the power of observation in the field will be of great value.

What is required for the field is a large field of view combined with good power in a short and handy instrument. The instrument should also have the power of making objects stand out clearly so that they may be readily distinguished. This latter quality is very important and should be combined with the highest power consistent with size and weight.

The natural power of observation of any object and of its shape depends greatly on the possession of two good eyes of nearly equal power. If one eye be stronger than the other, it may be to some extent corrected if each eye piece of a binocular can be separately focussed.

(*a*). As a rule the pupils of our eyes are about 2½ inches apart, and supposing we can perceive with the naked eye an angle of ½ a minute, then, since 2½ inches subtends this angle at 500 yards,* it follows that we should be able to appreciate the true position of objects relative to one another fairly accurately (especially if trained in judging distances) up to 500 yards with the naked eyes.

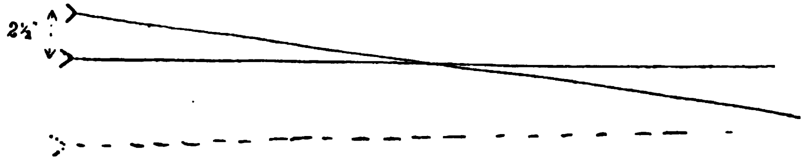


FIG. 1.

Again, if the thumb is held about 18 inches in front of the face, and looked at, it will readily be noticed that anything short of or beyond the thumb appears double; and if first one eye is shut then the other, whilst still looking at the thumb, the thumb will appear in quite a different position.

This so-called parallax of the two eyes is nothing more nor less than nature's range-finder. It gives a natural means of appreciating the distances of things within a radius of some 500 yards.

If the eyes were twice as far apart, it would be possible to appreciate the distances of objects to twice the former distance, *i.e.*, to some 1,000 yards, since 5 inches subtends ½ minute at 1,000 yards; and further if the eyes could be separated 8 times the natural distance, it may be supposed (other things being equal, which they are not, as shown below) the parallax would enable an observer to judge the position of objects up to 8 times the 500 yards distance, *i.e.*, to 4,000 yards!

(*b*). If a halfpenny (which is 1-inch across) be placed on its edge against a light back-ground at 200 yards distance,† it will represent an angle of half a minute to the eye. But if the halfpenny is observed through a small telescope (having say a power of 2 to 1) the magnified image of the halfpenny will make an angle of one minute to the eye; or, if the power of the telescope be 4 to 1, the image of the halfpenny will make an angle of 2 minutes to the eye; or, the halfpenny might be placed at four times the distance, and its image would make an angle of half a minute to the eye.

(*c*). Supposing now that in one instrument the powers described in (*a*) and (*b*) be cambined so that a prism binocular or double telescope shall increase the distance between the eyes 2 to 1 or say 8 to 1, and also have a magnifying power of 8 to 1, then it may be said the powers of observation will be increased 16 to 1 or 64 to 1—*i.e.*, were the atmosphere perfectly clear. An observer will be able to appreciate distances up to 8,000 yards or 32,000 yards with such instruments as readily as distances up to 500 yards with the naked eyes!

This appear a highly exaggerated statement, and of course it is so, looking at the question from other points of view and taking into consideration other factors influencing the powers of vision. For instance, in this country there is not often an extensive view nor is the atmosphere often clear. The glasses of a telescope also offer some resistance to sight. Nevertheless (*a*), (*b*) (*c*) are in themselves important facts which throw some light on the advantages to be gained by separating the eyes as far as possible and by increasing the magnifying power of glasses.

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* As pointed out by Dr. C. Pulfrich.

† I am indebted to Professor Greenhill for this illustration.

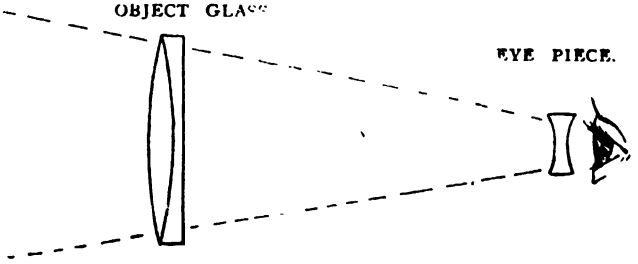
Again, when an ordinary telescope is used, no matter how great the power, it can only magnify the view of the object as seen from a certain spot. But, with certain prism binoculars and stereotelescopes, the eyes are enabled to view the object from points separated by a greater distance than the eyes are by nature, thus not only increasing the parallax (mentioned above as assisting in judging distance) but adding more shading to the picture, making it possible to see further round the object, making the object appear solid and causing it to stand out from its sourroundings. Thus indistinct objects are rendered more clearly visible.

In war every little advantage that can be obtained must be made use of.

It remains to explain how instruments, having the above advantages, and others besides, are constructed.

The ordinary binocular consists of two "Galileo" telescopes. These telescopes have lower power not often more than 4 or 5 to 1 and their field of view is limited, the maximum field even with low power not exceeding some 6°. And, as the power is increased, the field rapidly diminishes.

FIG. 2.

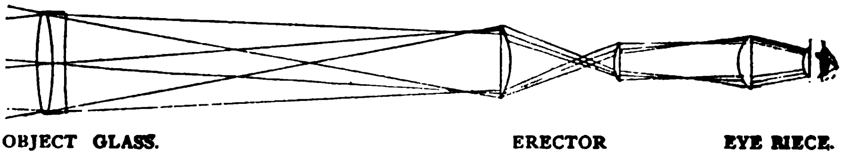


Sketch of Galileo Telescope

In the Galileo telescopes the lenses consist of an achromatic object glass and a diminishing eye piece. The size of the object glass in an ordinary binocular is limited by the width between the eyes. The focus of the object-glass is behind the eye lens, which fact limits the angle of view. The telescope is short as the length between the object-glass and eye-piece equals the *difference* between their focal lengths.

The advantages are that they are short, light, handy and efficient where small power is required. They are well suited to opera-houses and race-courses.

FIG. 3.



Sketch of Terrestrial Telescope.

The terrestrial telescope (Fig. 3) consists of a double achromatic object-glass, with an eye-piece further from the object-glass than the eye-piece of a Galileo telescope would be, because the length from the object-glass to the eye-piece is equal to the *sum* of the focal lengths of the object-glass and eye-piece. The eye-piece is not a simple magnifying eye-piece but has other two additional lenses as shown in the sketch, which re-invert the object, already inverted by the object-glass. This further adds to the length of the telescope. Theoretically there is no limit to the size which the object-glass may be made or the power for which the telescope may be designed.

The field of view diminishes as the power increases, but the field of view which can be obtained by the most modern form of terrestrial telescope say of power of 8 to 1 is equal to the field of view obtained with the Galileo telescope of 4 to 1.

The defination and light obtained are both good for all parts of the field, whilst the outer edges of the field of the Galileo telescope are not satisfactory.

The advantages of the terrestrial telescope are great power with good field, but hitherto there has been the great disadvantage for field work of want of lightness, handiness and portability. It will be seen from what follows that in prism telescopes the disadvantages have been overcome.

FIG. 4.

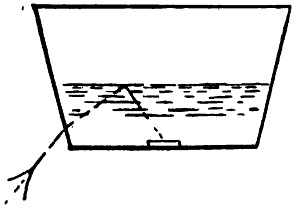
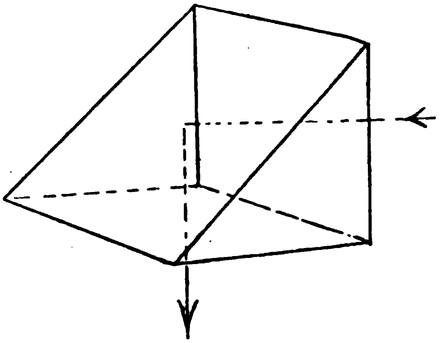


FIG. 5.



Use of prisms.—If a sixpence is placed in a glass with a little water in it, and the glass is then held so that the observer can look at the surface of the water from below (as shown by dotted line in Fig. 4), the sixpence will be seen reflected as though it were really on the surface of the water.

Or, if the observer take a right angle prism of clear glass having perfectly polished surfaces, on looking through one of the sides adjacent to the right-angle, objects at right-angles with the line of sight will be seen as if they were straight in front of the observer.

This total reflection does not involve any refraction, nor is silvering of surfaces required.

These two points are of utmost importance. Such prisms would doubtless have been used long ago as proposed by Porro and others, but, until comparatively recently, details of manufacture and expense of manufacture—as is seen in so many other cases—rendered their universal application quite impossible.

Binoculars.—The right-angle prism has been turned to great use by inserting two of them in each tube of a (so-called) terrestrial binocular telescope in the manner shown in Fig. 6.*

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* Figures 6 and 10 are reproduced from 'electros' kindly lent by Messrs. Carl Zeiss of London for the purpose.—Secretary R. A. I.

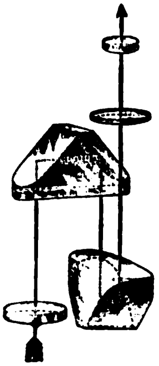
The fourfold reflection from the two right-angle prisms greatly reduces the length of the telescope, by, as it were, folding up the rays from the object-glass. The image is at the same time erected, thus doing away with the two erecting lenses and still further reducing the length of the telescope.

By this means, without loss of light and with an increase of field of view, there is placed in a case of the same size as a small binocular, a glass as powerful as a small telescope. And by placing the object-glasses on the outer sides of the instrument, the effective distance between the eyes is nearly doubled. Thus the stereoscopic effect is proportionately increased.

A view of the binocular is seen in Fig. 7, its chief characteristics are :

1. High power combined with large field.
2. Nearly double the natural stereoscopic effect.
3. Capability of focussing each eye-piece separately.
4. Solid aluminium, therefore of medium weight.

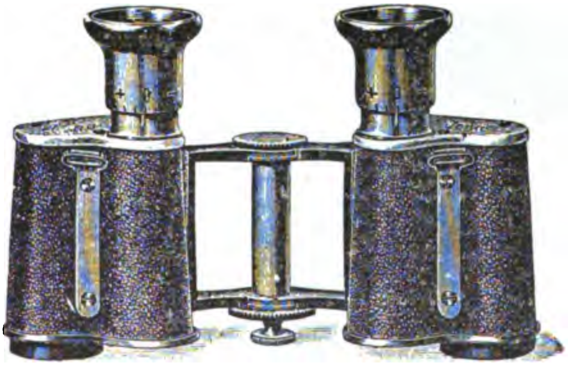
Fig. 6.



Optical arrangement of the Field-glasses.

Stereo-telescope.—But the development has not stopped here. The great value of stereoscopic effect and how mere increase of magnifying power cannot make up for lack of this effect, gradually dawned on the makers and it became apparent that width between the eyes could be increased indefinetely as seen in Figs. 8 and 9 by a slightly different construction. Three right-angle prisms for each eye are used instead of two. The focal length of the object-glasses is made full use of, not being "doubled up" as in the binocular, thus greatly increasing the width between the object glasses (Fig. 9) and thereby increasing proportionately the stereoscopic effect. The power of these telescopes are at present made up to about 15 to 1.

Fig. 7.



← *Distance between object-glasses* →

Field-glass magnifying 6 ×.,

(½ Full size).

This great increase of stereoscopic effect has proved so valuable that an attempt has been made to use such an instrument for range-finding, and very beautiful instruments they are, but "that is another story."

There is still another advantage in these stereo-telescopes. They arehinged in the middle, so that they fold up and are easily carried, and when folded up they can still be used, and in such a manner that the observer is able to continue his observations whilst still under cover of a parapet, wall, rock bank, or any other suitable protection (Fig. 10). When the instrument is opened out (Fig. 9) observations may be carried out from behind a tree.

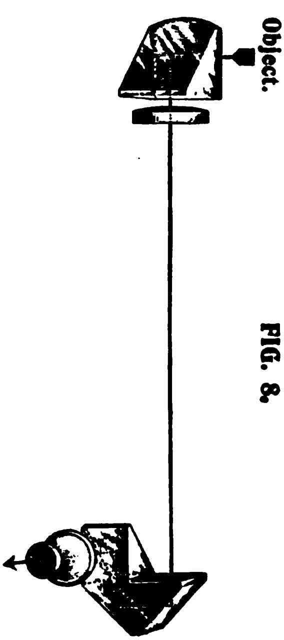


FIG. 8.

Optical arrangement of the Stereo-telescopes.

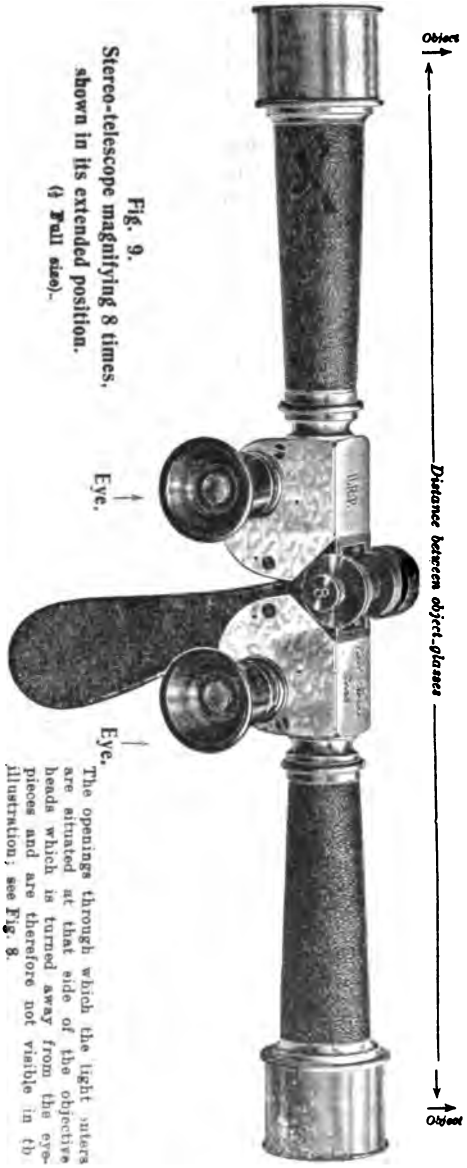
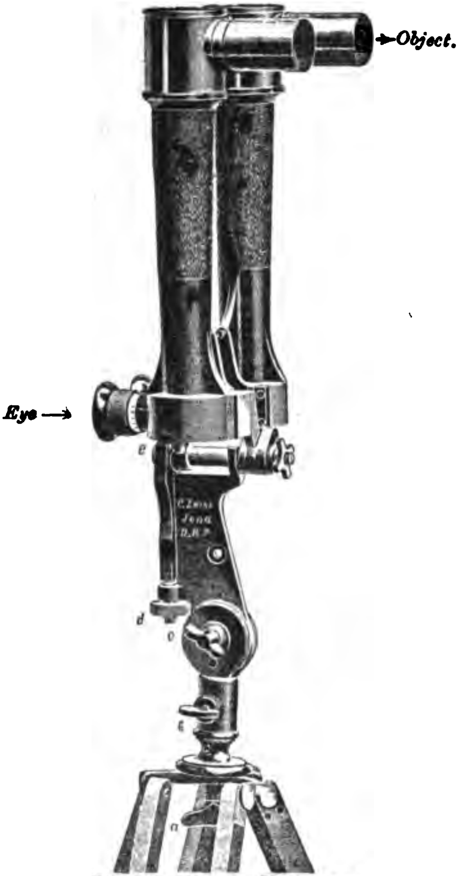


Fig. 9.
Stereo-telescope magnifying 8 times, shown in its extended position.
(½ Full size).

The openings through which the light enters are situated at that side of the objective heads which is turned away from the eye-pieces and are therefore not visible in th illustration; see Fig. 8.

Cover must play an increasing part in modern warfare, and to observe from behind cover becomes increasingly important.

FIG. 10.



Hinged Stereo-Telescope with upturned limbs. (¼Full size.)

The following tables have been made out with a view to giving a general knowledge of existing forms of glasses and where they may be obtained. The details of the glasses are given as fully as possible.

From 1 to 6 are the best prism stereoscopic binoculars and stereotelescopes, 7 to 9 types of ordinary field binoculars, 10 to 13 are monocular prism glasses. From 7 to 9 are inserted for purposes of comparison only—as they have no increased stereoscopic effect.

Instruments recommended for special purposes.—This is a difficult matter andnot to be lightly undertaken, but it is time the subject was mooted, and as this embodies some of the experience volunteered by men who have used many glasses in various climates, it may not be very short of the mark and may at least serve to promote discussion.

For units.—Horse and Field Batteries should have the largest size stereotelescope that can be conviently carried with the Battery, say No. 6 in the list or even a bigger one giving a four foot six width between the object-glasses and a much higher power. A few men who prove most efficient with it should be specially selected and constantly exercised in its use. This training and constant use are of the highest importance, no perfection can be obtained until the eyes have become used to the stereoscopic effect and until hand and eye work together.

In very strong sun light "smoked" glasses should be used with the instruments.

The stereo-telescope would be principally of value for:

(*a*) reconnaissance; (*b*) observing effects of fire; (*c*) noting the changing tactical conditions of the fight, varying as they constantly do. This might occasionally prevent unpleasant surprises.

For Artillery. Magnifying power and stereoscopic effect are of first importance, special points of the field require to be most carefully searched.

For Cavalry. Each troop leader and all higher ranks should be provided with a similar instrument (say No. 5 in list) for examining doubtful objects at long distances.

No.	Discription.	Linear Magnification.	Field of View Angular.	Field of View Linear in yds. per 1,000 yds.	Stereoscopic Effect.	Weight without cases.	Length by breadth of instrument	Price.	Maker.
	I.								
1	Binocular (prism stereoscopic)..	4	9.3°	162	1¾	12½ oz.*	2¾″ × 5½″	£ 6 10	Carl Zeiss, Jena, Germany, and at 29 Margaret St., Regent St., London, W.
2	Binocular (prism stereoscopic)..	6	6.2°	108	1¾	13½ oz.*	3½″ × 5½″	£ 7 0	
3	Binocular (prism stereoscopic).	8	4.6°	81	1¾	14½ oz.*	4 ″ × 5½″	£ 8 0	
4	Stereo-telescope........	8	4.6°	1	5	21½ oz.†	8½″ × 4½″	£ 9 0	
5	Stereo-telescope........	10	3.7°	65	6½	28 oz.†	10½″ × 4½″	£10 0	
6	Stereo-telescope........	15	2.6°	46	9	3¾ lb.‡	13 ″ long.	£21 5	
	II.								
7	"Aitchison Pocket".	6	3°	50	1	About 7 oz.	...	£ 5 5	Messrs. Aitchison, 428, Strand.
8	"Yeomanry".........	4	3½°	65	1	16½ oz.	...	£ 3 3	Messrs. Mappin & Webb.
9	"Aide-de-camp".....	5½	No particulars in Catalogue.			24 oz.	...	£ 6 6	Messrs. Steward, 406, Strand.

Binocular (prism) but without increased stereoscopic effect but in other respects varying little from Zeiss's are supplied by Messrs. Goerz, 4, and 5, Holborn Circus, E.C., and by Messrs. Ross, 111, New Bond Street.

No.	Discription.	Linear Magnification.	Field of View Angular.	Field of View Linear in yds. per 1,000 yds.	Stereoscopic Effect.	Weight without cases.	Length by breadth of instrument	Price.	Maker.
	III.								
10	Monoculars (prism)	3	13.3°	225	Nil.	Not given.		£ 2 10	Messrs. Goerz, 4 & 5 Holborn Circus, E.C.
11	do.	6	6.7°	115	"	"	"	£ 3 0	
12	do.	6	4.4°	80	"	"	"	£ 3 10	
13	do.	12	3.3°	60	"	"	"	£ 4 0	

Monoculars (prism) Zeiss's, are similar in all respects to 1, 2, 3 above, except no stereoscopic effect and are ½ the weight, size and price.

* Cases about 11 oz. † Cases about 12 oz. ‡ Case 1½ lbs.

For Coast Defense. A No. 6 stereo-telescope is recommended for the use of the Battery and Fire Commander of every Coast Defense Fort.

For individuals.—For cavalrymen, artillerymen and infantrymen No. 3 in the list, *i.e.*, an 8 power prism binocular is recommended.

This it is understood is the glass much used in the German Army, it has a large field of view and good stereoscopic effect. It is a good glass for general field use.

For scouts, it has been suggested that one leg only of No. 4 or 5, *i.e.*, the stereo-telescope with 8 or 10 power would be very useful as being a good glass which could be used behind cover.

Makers.—It is not pleasant to have to confess that field glasses having stereoscopic effect cannot be obtained from any English firm as Messrs. Carl Zeiss hold the patent. But it is good to know that a most distinguished English optician has said that Messrs. Zeiss well deserve their success.

Conclusion.—By continuing to use ordinary binoculars in the British Army, in preference to the beautiful prism stereoscopic binocular, on the plea that the latter, though superior, are complicated, expensive and likely to get out out of order, history is repeating itself. It is a repetition of the mistaken policy of clinging to obsolete M. L. guns long after B. L. guns had proven their excellence.

—*Proceedings Royal Artillery Institution*, December, 1900.

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BOOK REVIEWS.

The Second Boer War, 1899-1900. By Captain John P. Wisser, Artillery Corps, U. S. A. Hudson-Kimberly Publishing Company, Kansas City, Mo.

Captain Wisser's work is a tactical and strategical study of the recent South African War. The author's aim has been to accumulate and set in order the facts of the war, and from these to unfold the principles of tactics and strategy involved. The spirit of the work is scientific and hence free from bias.

The account of the war is based on a study of the wide list of exchanges of the *Artillery Journal* in English, German, and French, in connection with the principal books that have been issued in these languages. The work involved here has been very great; the result is a clear, precise, detailed narrative. The maps are numerous but detached; we would have preferred to have them bound in atlas form, and the study of the work would have been facilitated by more numerous references in the text to the proper accompanying map. The critical comments, the author tells us, are based largely on foreign studies, but their consistency and individualty are so marked, that it is not difficult to discern that they derive their life from Captain Wisser's own reflections on the art of war, a subject that has been his special study for many years.

The views of the writer on the fundamental principles of war are very positive, and well set forth and illustrated at every step. There is only one real way of making war, in his opinion, and that is by attacking. This is the cardinal lesson he deduces from the Boer War. It is not of course an unconsidered push forward, or a purely frontal attack that is intended, but an attack preceded by a careful reconnaissance to determine the position and discover the weaknesses of the enemy, an attack always accompanied by flank movements, developing at times into far out-flanking movements if the enemy has taken countermeasures. The defensive is considered justified only when auxiliary and subordinated to the offensive. Thus a part of the theatre of war may be held by small numbers that another part may be reinforced; or in battle a thin line may hold their position in a defensive attitude in order that a large force may be concetrated for a forward movement in another portion of the field.

The second great lesson that the author deduces is the necessity of concentration. Like the adoption of the offensive this principle holds good both in the domain of tactics and strategy. The British failures in the early part of the war are shown to be largely due to a scattering of their forces.

While concentration and offensive operation are the paramount lessons that the book teaches, yet hardly any portion of the wide field of tactics and strategy is left untouched. Preparation, reconnaissance, communication, the fire action of infantry, the handling of cavalry, the use of artillery are all discussed and illustrated. The work as a whole is a brief but masterly exposition of the principles of modern war-fire. G. B.

Practical Military Sketching. By C. F. Vander Byl, 16th Lancers. Fully Illustrated. Pp. 75. Aldershot and London : Gale and Polden, Ltd. Three Shillings and Six Pence.

This little volume is a useful hand-book on a very important military subject, which it treats in a simple and practical, but at the same time thorough way. It is full of useful information, and is evidently the work of one at home in the subject.

In setting forth the scope of the book the author, after explaining the essential difference between a *sketch* and a *survey*, goes on as follows :

"It is, however, with sketching only that we shall now have to deal, and it should be remembered that the chief points to be aimed at are accuracy, neatness and rapidity. A sketch should be plain, and to be plain it must be neat.

"The system which is now generally used for sketching is that known as plane-tabling, and it has this advantage, that, when a plane table is not available, almost anything may be used as a substitute, the legs being altogether dispensed with. In this way fairly accurate work may be done on a sheet of paper attached to a spare lid of a box and held in the hand, the system employed being exactly the same as when using the plane-table itself."

After defining the terms used in topography and explaing the use of the conventional signs, the author opens the subject proper with a very practical and simple discussion of scales, continuing with a useful chapter on map reading. Sketching is considered under three heads : intersection, traversing, and contouring, each of which is illustrated by many practical examples, and under this subject are considered the selection of a base, the use of a secondary base, the angular and linear tests of a sketch for accuracy, orientation, and offsets. Succeeding chapters treat of the prismatic compass, slopes and horizontal equivalents, hill sketching, eye sketching, the cavalry sketching case, the magnetic compass, night marches and attacks, maps, reconnaissance and road making.

This work is well illustrated and will prove useful in the field to any officer of whatever branch of the service he may be. J. P. W.

Die Flottenführung im Kriege, auf Grund des Doppelstaffel-Systems. Rudolf v. Labrés, K. und K. Linienschiffs-Capitain. Berlin : E. S. Mittler und Sohn. 1900. Pp. 423.

This work on naval tactics by Captain v. Labrés of the Austrian navy, based on the double echelon system, is the result of years of study and practical experience and observation.

The author's original work in this field dates back to 1884, but the present volume embodies the experiences of the past seventeen years, which have materially altered many previous conceptions. The literature on this subject of naval tactics is particularly meagre, and the author, if he has accomplished nothing else, has at least given the world a text-book on that important subject, which cannot fail to arouse interest. He has not only presented a system for maneuvering a fleet, but has also shown how it may be applied in actual war and battle.

The grand subdivisions of this work are general considerations of naval war, the formation of tactical combinations, evolutions of these units, the formation of other tactical units, the formation of the entire fleet for action or march, and the theory of naval tactics, with an appendix on the results of the late naval wars (Chino-Japanese, Turco-Greek and Spanish-American), the factors in naval engagements, and the training of the naval personnel for active service.

Each one of these general subjects is treated in great detail, and the work is illustrated by 260 diagrams in the text and 5 plates of figures, mostly illustrations of tactical movements of ships in action.

The work constitutes an excellent study of the subject of which it treats.

The first part may be called the drill regulations of the fleet, leading up to the Sea Tactics. The principles of sea-tactics are similar to those of land tactics, and in many respects identical. In both each force strives of obtain superiority by striking at the weakest point of the enemy and endeavoring there to obtain superiority of power by tactical measures; and in both the flanks and rear are, in general, the weakest points. The successive phases of a sea battle resemble those of a land battle. While a land battle has its reconnaissance and first artillery position, its duel position, its third artillery position and final assault; a sea battle has its distant action, its close range artillery action (within 3000 yards), its tactical close range action (in which torpedoes come into play), and finally the tactical melée. The author considers these phases in turn, and illustrates the tactical movements liable to come into play.

The last part is the application of naval tactics as exemplified in the recent wars.

The work is unique in character, and with its numerous illustrations is well suited to be the world's text-book on the subject, as it practically is.

J. P. W.

Handbook der Truppenführung im Kriege. Gustaf Dickhuth, Major im Grossen Generalstabe. Berlin: E. S. Mittler und Sohn. 1901. Pp. 344.

The great authority on tactics in the German army, and indeed elsewhere in the military world, has been for many years the work on that subject by Meckel, a work of wide reputation and deserved popularity, which reached its third edition in 1890. This work has been discontinued, and the present one, though differing in many respects, is practically its successor.

The *art* of war or troop leading, like every other art, consists in being able to practically do, not in simply knowing theoretically how to do, and the purpose of this work is to furnish the young officer a hand-book which will assist him in practically applying drill regulations and principles of tactics in the field in presence of the enemy. The works on tactics and the various drill regulations are written with a view to their use in instruction in time of peace, whereas in actual war perhaps the very first step towards the enemy will involve an *exception* to the rules and conditions there set forth, hence the necessity and importance of a work like the present.

Moreover, many *forms* have to be taught in time of peace which are inapplicable or false in actual war. For example, on the drill ground, in practicing the formations for battle, the defender will remain lying and firing until the attacker is close up to the muzzles of the guns. This is necessary to train the soldier never to retire without orders, but to make the best use of his weapon to the last, and on the other side to give the soldier the idea that he must push forward firmly and surely to hand-to-hand conflict if necessary. But in actual war such a picture would be impossible, for either the attacker has seized the right moment and the defender will then give way, or the movement was not ripe for the attack, in which case the defender calmly holds out and the attack fails. Nevertheless, this false form must be taught in time of peace, for we cannot teach our men to run as soon as the attack begins.

There are many such instances of forms in drill regulations and maneuvers which would be entirely different before an actual enemy.

In studying tactics it must be constantly borne in mind that there are no fixed *forms*, or *rules* or *systems*, everything depends on circumstances and no particular situation will probably ever accurately repeat itself. Experience, careful study and consideration and prompt decision are the only aids to correct action, and these come into play not only on the battle-fieled, but in everyday duty : orders for the march, camping, reconnaissance and outpost duty, even subsistence.

In the wide field of troop leading only the *limits* within which the present circumstances may confine us can be fixed, and in time even these limits are extended. Tactics can therefore teach only the manifoldness of the forms and circumstances which may arise. Therefore is military history so important a subject of study, as presenting this manifoldness in actual reality. That and actual experience with troops alone can teach us what books cannot —*troop leading*. The sculptor cannot teach his art by writing a book on the subject, his best legacy to posterity is his finest statue : so it is with the military leader, what he has *done* must be studied.

The work before us is eminently practical and calls attention throughout to the forms and methods used in actual war. It is, as its title indicates, a hand-book on the subject, and sets forth the application of these methods in the field, laying stress on the spirit of the regulations as opposed to the mere form. It is undoubtedly one of the best works on this subject that has appeared and will remain the standard of authority for some time to come as Meckel's was before it. J. P. W.

Der Buernkrieg in Südafrika. Oberst Ritter v. Gerneth. III. Berlin : E. S. Mittler und Sohn. 1901. Pp. 290.

The third part of this valuable history of the Boer War, perhaps the most satisfactory of all as a strategical and tactical study, was not completed by the author of the first two parts (Major v. Estorff), but by the author of the history published in the *Militär Wochenblatt*, Colonel v. Gerneth.

The latter was fortunately thoroughly qualified to continue the work, as he had himself carefully studied the war from its inception. Major v. Estorff was compelled to give up the completion of his excellent history, on account of his transfer to the German troops in East-Africa.

The present number begins with Lord Roberts' advance towards Bloemfontein after Cronje's surrender, and ends with the occupation of Lydenburg and the departure of President Krüger.

The subject-matter is presented in a fair and unprejudiced spirit, with full and free criticisms of both British and Boer tactics and strategy, in fact, the entire work constitutes the finest military study of the entire war that has yet been presented.

Both authors are evidently military students of a high order, and their work is effective, brilliant and rich in lessons. It is not merely a clear presentation of the events as they succeeded one another, but a careful and intelligent study in the light of modern tactics and strategy, showing the bearing of particular movements on the plans of the generals commanding.

The battle of the 7th of March, for example, illustrates Lord Roberts' tactics of holding the enemy's front with the infantry, and turning his flanks with the cavalry and mounted infantry, but it also shows what the English were mostly lacking in, viz : the weakness of the service of security and information (or reconnaissance) and their failure to carry out an effective pursuit, both of which merely prove how necessary it is to practice these in time of peace, The Boers, on the other hand, are criticised for the adoption of too extended a front, their lack of unity of command and purpose, and their too great individuality or independence, due to lack of discipline.

In the advance from Bloemfontein to Kroonstad Lord Roberts' widely separated columns are justified by the wide front and tactical behavior of the Boers, but could not lead to decisive actions on the field. The poor tactics of the Boers broke their spirit, prevented unity of action and led to continual retreat.

The further British offensive advance to Pretoria, and finally the campaign towards Middelburg, as well as the isolated but very interesting events in rear of the main army, are all set forth with a master hand, and leave nothing to be desired in the way of intelligent comment and criticism, and the lessons to be learned are but too plain and evident.

Although brief, no better study of the purely military features of the war can be found. The maps are adequate and descriptions are clear and graphic, while the comments and criticisms are those of men thoroughly familiar with military history and the great principles of the art of war.

J. P. W.

Untersuchung über die Vibration des Gewehrlaufs. C. Cranz und K. R. Koch. 1. Schwingungen in Verticaler Ebene. B. Versuche with Kleinkalibrigen Gewehren.. Munich : Verlag der K. Akademie.

This pamphlet is a continuation of the interesting experiments of Professor Cranz and Koch, on the vibration in the vertical plane of small-caliber rifles when fired, and constitute a most valuable addition to the literature of ballistics, especially in relation to the causes of the so-called *jump*.

The experiments were carried on with an 8 mm., a 7 mm. and a 6 mm. gun, and consider not only vibration of the barrel at different points (in the vertical plane), but also the recoil longitudinally, testing both under various conditions with full and with diminished charge.

The results are as interesting and instructive as their first series of experiments (previously reviewed in the *Journal*), and it was found that the projectile left the bore, in the case of the small-arms used, at different points of the curve of vibration of the barrel.

As remarked in our previous review, these experiments are classic in their field, and deserve most careful study by ballisticians. J. P. W.

Studies in Field Engineering. An aid to passing the practical examination in this subject. Lieut.-Col. Wilkinson J. Shaw. London : Gale and Polden, Ltd. Four Shillings.

The primary object of this work is to provide a manual which may serve as a guide for officers preparing for promotion, especially as regards the *practical* examination required in field engineering.

Colonel Shaw, the author of this useful little work, is already well known as the author of "The Elements of Modern Tactics," and the thoroughness and practical sense exemplified in the latter are also in evidence in his present book. He has taken as the basis a few of the problems recently set by the Examining Board to officers undergoing examination for promotion, and has presented simple practical solutions for each.

The nature of the problems can be gathered from the following, selected at random :

Bridging a stream.
Placing a building in a state of defence.
Demolishing a bridge.
Prepare a village for defence.
Construction of a redoubt on a selected site.
Arranging a railway station for entraining a force.

In each case the officers are required to explain from written notes, hand-sketches and plans, the character of the work required, the number of men and the materials and time that will be necessary for this work.

The problems are all of real interest to officers of all arms, and are such as may be required in the field of any of them, consequently this work should prove most acceptable to our army as well as the British, and can be recommended to our officers as worthy of careful study and consideration.

J. P. W.

The Marvels of Modern Mechanism and their relation to Social Betterment. Jerome Bruce Crabtree. Springfield, Mass. : The King-Richardson Company. 1901. Pp. 750.

The history of our civilization, so far as it was affected by the inventive genius which evolved the marvelous machinery of our time, is the theme of this comprehensive work. It is intended for the general reader, consequently all technical discussions or details are carefully avoided, so far as accuracy of statement and description will permit.

The work is a remarkable collection of information, and virtually a cyclopedia of reference on the great subjects treated. The latter include modern machinery (its benefits to mankind), Power, Transportation, Electricity, Iron and Steel Working, Means of Communication, Agricultural Machinery, Optics, Modern Surgery, and Modern Occupations for Women.

To give some idea of the method of treatment of the subjects we will attempt a brief analysis of the article on *Transportation*.

Opening with some general remarks on the relations of civilization and trade to transportation, the author takes up the Roman roads, the value of transportation to England, the early American roads, and the primitive roads of South America ; then passes on to the early history of railroads (which contains some very interesting and instructive items, among which may be mentioned in passing the origin of "tramway" from Outram, who in 1800 used stone sleepers for his railroad). The growth of rail transportation in the United States is next considered, followed by the beginning of railroad consolidation. The history of railroads is traced to the present day when the mileage of tracks in the United States would more than suffice to reach the moon.

"Nothing can better show the rapidity with which transportation systems have developed than the simple fact that engine No. 999, the best that American skill could produce, exhibited at the World's Fair in Chicago and honored by being assigned to the Empire State Express, is now relegated to drawing local trains on a subordinate road of the New York Central."

The material of railroads, their building, the engineering feats, and their management are all treated, briefly but graphically. The Railroads of Canada, the Panama Railroad, and the Trans-Siberian Railroad also receive attention, and incidentally train operation, the block signalling system, brakes, interlocking switches and the closed vestibule are discussed.

After this full treatment of the subject of railroads, follow most interesting remarks on the world's great tunnels, and the subjects of rapid transit, electric railways, and subways.

The article closes with the history and statistics of wheeled vehicles (including bicycles and automobiles), balloons and flying machines, and finally water transportation in all its forms.

This analysis will give an idea of the scope of the work and the general character of the articles; but there is strong temptation to present the ground covered by other great chapters in the book, especially those on Electricity, Iron and Steel and Military Science.

The historical portions are brief and always most interesting, containing only such facts as are of general interest and necessary to an understanding and appreciation of the development that has taken place. The great value of the work lies in its accurate exposition of the *present* state of all the subdivisions of science and mechanism which fall under its consideration.

The book is well printed and bound. There are about twenty full-page illustrations. and many smaller ones scattered through the text. Among the contributors other than the author, in the way of complete articles or reliable data, may be mentioned Carroll D. Wright, LL.D., Willard Smith, M.D., Colonel J. P. Farley, Ordnance Department, U. S. Army, the Bethlehem Steel Company, Professor Kerry of McGill University, etc.

The comprehensive, reliable and up-to-date character of this work entitle it to a place in every good library.
J. P. W.

The Spanish Verb, with an Introduction on Spanish Pronunciation. 1st Lieut. Peter E. Traub, 1st U. S. Cavalry, Assistant Professor of French at the U. S. Military Academy. New York: American Book Company.

Owing to the acquisition of our new territory in the Atlantic and Pacific as the result of the Hispano-American War of 1898, an intimate knowledge of the Spanish language has suddenly become of great military, naval, industrial, and commercial importance. The Pronunciation and the Verb are the prime factors of this knowledge, since without them the intelligent expression of thought would be impossible.

The necessity for writing this book lies in the fact that there is no treatise on the Spanish verb in existence, and no satisfactory work on Spanish pronunciation.

This book embodies the results of the corresponding portion of the system in vogue at the United States Military Academy.

The portion treating of pronunciation is in accordance with the latest teaching of the Spanish Academy, and takes into account the peculiarities attending the Spanish-American speech as found to-day in our Island possessions. The system followed in the verb is that of constant repetition, every verb being fully written out, even the English translation in each case. Experience in teaching convinces nearly all instructors that constant and unabridged repetition, not only for the ear but also for the eye, is the only correct way to teach a language, and more especially the verbs of a language.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Military Law Made Easy. **Major S. T. Banning,** Instructor in Military Law, Royal Military College. Aldershot: Gale & Polden, Ltd. Four Shillings and Six Pence.

Boxing. Captain W. Edgeworth Johnstone, Assistant Inspector of Gymnasia, Heavy Weight Amateur Champion of England, 1895-6. London: Gale & Polden, Ltd. Two Shillings and Six Pence.

L' Artillerie A L' Exposition de 1900. Le Colonel X. Paris: Vve. Ch. Dunod, Editeur. 1901. Seven Francs, Fifty Centimes.

Le Nouveau Materiel D' Artillerie De Campagne Suisse Modele 1901. Lausanne: *Revue Militaire Suisse.* 1901.

Kriegsgeschichtliche Beispiele des Festungskrieges aus dem deutsch-franzosischen Kriege von 1870-1. Von Frobenius, Oberstleutnant a. D. Fünftes Heft. Berlin: E. S. Mittler und Sohn. 1901. Pamphlet, 3.75 Marks; bound, 5 Marks.

Idioma Nacional de los Argentinos. Antinomia Linguistica Insoluble. Dr. Luciano Abeille. Buenos Aires: Local del *Circulo Naval.* 1901.

L' Armement De L' Infanterie. Apercu Historique. Le Colonel Rubin, Directeur de la Fabrique federale de munitions, a Thoune. Lausanne: *Revue Militaire Suisse.* 1901. Two Francs.

Sulla Teoria Delle Travi E Dei Lastroni Di Cemento Armato Caricati Di Pesi. Crescentino Caveglia, Colonnello del Genio. Roma: Enrico Voghera.

Catalogo Historico E Discriptivo do Museu Naval, 1901. Rio de Janeiro: Typographia Leuzinger.

The Words for Infantry Bugle Calls used in Infantry, Mounted Infantry, Garrison Artillery, R. A. M. C., etc. By Corpl.-Trumpeter W. H. Reid. London: Gale and Polden, Ltd. Price Three Pence.

The Words for Trumpet and Bugle Calls used in Cavalry, Yeomanry, Artillery, Army Service Corps, etc. Corpl.-Trumpeter W. H. Reid. London: Gale and Polden, Ltd. Price Three Pence.

Appendice alla Teoria delle Travi e dei Lastroni di Cemento Armato Caricati di Pesi. Crescentino Caveglia, Colonnelo del Genio. Roma: Enrico Voghera. 1901. Pp. 14.

INDEX TO CURRENT ARTILLERY LITERATURE.

[For Abbreviations used in Index see first number of each *volume.*]

NEW EXCHANGES.

American Electrician. [*Amer. Elec.*] *Monthly.*
120 *Liberty Street, New York.* *Per year* $1.00.

Military Mail. [*Mil. Mail.*] *Weekly.*
2, *Amen Corner, E. C., London, England.* *Per year* 8 *Sh.*, 8 *pence.*

Norsk Artilleri-Tidsskrift. [*N. Art. Tids.*] *Bi-monthly.*
Christiania, Norway. *Per year* $1.50.

Revista del Circulo Militar. [*R. Circulo Mil.*] *Monthly.*
Calle de Suipacha No. 383, *Buenos Aires, Argentina.* *Per year* $ m/n 15.00.

ORGANIZATION AND ADMINISTRATION.

Organization of the French armies, 1791 to 1815.—**Monde**, January 15-31; February 1-15; February 15-28.

Colonial troops.—**Jahrbuecher**, February.

Reorganization of the Engineers and Pioneers of the German Army.—**Jahrbuecher**, February.

Recruitment of the French army in 1899.—**Jahrbuecher**, February.

Changes in the world's armies.—**Jahrbuecher**, February-March; **Jour. R. U. S. I.**, February-March; **Int. Rev.**, March-April; **R. Artig.**, February-March.

History of the Austrian troops for security (Gendarmes, etc.)—**Jahrbuecher**, February.

Organization of a General Staff (Allen, Scherer, Langdon).—**Jour. M. S. I.**, March.

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National Responsibility.—**Jour. R. U. S. I.**, February.

French naval budget for 1901.—**Seewesens**, III.

Military evolution in Germany and in France.—**Monde**, February 15-March 15; **Quest. Mil.**, January.

Mounted infantry.—**Wochenblatt**, March 6.

Italy and France (navies).—**A. and N. Gaz.**, March 9.

The new German military establishment.—**A. S. M. Zeit.**, February 23.

Reorganization of the U. S. army.—**Cercle**, February 23.

Some causes of inefficiency in the Navy.—**Unit. Serv. Mag.**, March.

Notes on the Evolution of Cavaly.—**Unit. Serv. Mag.**, March, April.

A Civilian-Ridden Nation.—**Unit. Serv. Mag.**, March.

The future function of the militia.—**Unit. Serv. Mag.**, March.

The volunteer force.—**Unit. Serv. Mag.**, March.

Organization and working of railway corps.—**Jour. U. S. I.**, India, January.

History of the French infantry.—**R. Inf.**, February, March.

French and Germans.—**R. Univ.**, March.

Field telegraph service in Portugal. **Engenheria M.**, January.

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The naval estimates.—**A. and N. Gaz.**, March 16; **U. S. Gaz.**, March 16; **Eng.**, March 15; **Eng'ing.**, March 22.

The Russian volunteer fleet.—**Cas. Mag.**, April.

The cavalry corps.—**R. Cav.**, February, March.

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The American army since the Spanish War.—**Jahrbuecher**, March.

The measures of Russia in China.—**Jahrbuecher**, March.

The Italian, French and Spanish mountain troops.—**Cientifico M.**, February 15; March 1.

Infantry in a new century.—**Jour. R. U. S. I.**, March.

The law of conscription for the navy.—**Boletin, Argentina**, January.

Reorganization of the ultramarine forces.—**Exercito**, February.

The administration of our navy.—**Circulo Naval**, January.

Organization of the personnel of the British navy.—**Circulo Naval**, January.

The navy estimates.—**A. and N. Gaz.**, March 23.

The French navy.—**A. and N. Gaz.**, March 30.

Reduction of term of service.—**Belgique M.**, March 24.

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The Canadian militia system.—**Unit. Serv. Mag.**, April.

Mounted or mobile infantry.—**Unit. Serv. Mag.**, April.

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Organization of the Battery in some of the foreign field artilleries.—**N. Art. Tids.**, 4.

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TACTICS.

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The importance of the *initiative* in war.—**Vereine**, 1.

The combat of the advance guard in rencontre.—**Vereine**, 1.

How should cavalry attack infantry.—**Cercle**, February 16.

South African campaign (Austrian Attaché).—**Jour. R. U. S. I.**, February.

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Battle formations.—**Quest. Mil.**, January.

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Some tactical considerations arising from recent events in South Africa.—**Jour. U. S. I., India**, January.

Criticisms after campaigns.—**Jour. U. S. I.**, January.

Notes on the evolution of cavalry.—**Unit. Serv. Mag.**, March, April.

Hysterical warfare.—**Unit. Serv. Mag.**, March.

1815-1900.—**Unit. Serv. Mag.**, March.

Frederick the Great: Minden, Kunersdorf, Maxen.—**Unit. Serv. Mag.**, March.

Musketry and discipline.—**Unit. Serv. Mag.**, March.

The use of light railways in Indian warfare.—**Jour U. S. I.**, India, January.

History of the French infantry.—**R. Inf.**, February, March.

Historical essay on cavalry tactics.—**R. Inf.**, February, March.

A question of application in field service.—**R. Inf.**, February, March.

Study of a tactical question.—**R. Univ.**, March.

French and Germans.—**R. Univ.**, March.

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The II brigade division, Royal Field Artillery, in the Natal campaign, 1899-1900.—**Proc. R. A. I.**, January.

The visibility of uniforms in the field.—**Cercle**, March 16.

Davout and Bernadotte at Auerstaedt.—**Cercle**, March 16, 23.

Increased strength of coast defense.—**Mitth. Art. u. G.**, 3.

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The lessons of the 16th of August.—**R. Cav.**, February.

The Russian cavalry in the war of 1877-8.—**R. Cav.**, February, March.

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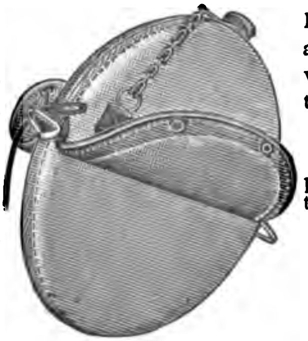
THE LANZ CANTEEN



Keeps water at a drinkable temperature in any climate. Liquids carried in this canteen will remain palatable for a longer period than in any other canteen heretofore used.

Prices and descriptive circulars showing practical tests sent to officers and men of the service on application.

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